OREGON CULVERT

FISH PASSAGE SURVEY

October 1990

Western Federal Lands
Highway Division,
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FEDERAL HIGHWAY ADMINISTRATION
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ABSTRACT

This report presents the findings from a fish passage survey conducted on various types of highway culverts. The survey includes 39 culverts located throughout the state of Oregon. To simplify the findings, the report places the 39 Oregon culverts into four categories: (1) pipes and pipe-arches with no special provisions for fish passage, (2) pipes and pipe-arches with special provisions for fish passage, (3) pipes and pipe-arches with natural stream beds, and (4) arches. Based upon the survey, the report concludes that culverts with natural stream bed surfaces provide the best facilities for passing fish. The report, also, presents procedures and criteria for designing and installing highway culverts that must pass fish. From the presented survey findings and the recommended design and installation methods contained in the report, the reader should, therefore, be able to resolve most problems associated with designing and installing highway culverts to pass fish.

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LIST OF SYMBOLS AND DIMENSIONS

Q2	Two year flood, in cubic feet per second (cfs)
Q50	Fifty year flood, in cubic feet per second (cfs)
Vch	Natural channel velocity, in feet per second (fps)
Vb	Culvert barrel velocity, in feet per second (fps)
HW	Headwater at culvert inlet, in feet (ft)
R	Rise of culvert, in feet (ft)
Nch	Manning's roughness value for the natural channel
Nb	Manning's roughness value for the culvert barrel
S	Stream channel slope, in feet per foot (ft/ft)
D50	Particle size from gradation curve such that 50 percent of the mixture is finer by weight, in feet (ft)
D	Pipe diameter or rise, in feet (ft)
Ke	Culvert inlet loss coefficient
H	Energy head for culvert flowing full, in feet (ft)
dc	Critical depth, in feet (ft)
TW	Culvert tailwater, in feet (ft)
ho	Height of hydraulic grade line above outlet invert, in feet (ft)
L	Culvert barrel length, in feet (ft)
So	Culvert barrel slope, in feet (ft)
VO	Culvert outlet velocity, in feet per second (fps)
WO	Width of culvert outlet, in feet (ft)
A	Flow area at the culvert outlet, in square feet (ft^2), or culvert drainage area in square miles
YE	Equivalent depth at the culvert outlet, in feet (ft)
FR	Froude number

LIST OF SYMBOLS AND DIMENSIONS (Continued)

HS	Scour depth at culvert outlet, in feet (ft)
P	Mean annual precipitation, in inches
F	Percent of basin forest
I	Precipitation intensity, in inches
ST	Area of lakes and ponds, in percent
TI	Mean basin January minimum temperature, in degrees
L	Length of channel, in miles

INTRODUCTION

In the autumn of 1987, the Western Federal Lands Highway Division (WFLHD) conducted a fish passage study of 39 stream culverts located in the state of Oregon. WFLHD had two primary goals in conducting the fish passage study. The first goal was to determine which type of culvert facilities provided the best fish passage. The second goal was to determine if current design practices would have identified these same culverts as providing the best fish passage facilities.

To meet these goals, WFLHD surveyed each site with a level and transit for topographic data, obtained stream bed gradations at each site, and obtained photographs of each culvert and its adjacent stream environment. Concurrently, WFLHD sent questionnaires to Oregon Department of Fish and Wildlife (ODFW) personnel requesting them to evaluate the importance and capability of each culvert to pass fish. Once WFLHD obtained the field data and received the completed ODFW questionnaires, they performed a hydrologic and hydraulic analysis of each site using WFLHD culvert design procedures. From the WFLHD field data, the ODFW questionnaires, and the WFLHD culvert design analysis, WFLHD determined which culvert installations provided the best conditions for fish passage.

This report presents the detailed findings from the WFLHD study. In the process of presenting the findings, the report also provides an approach for designing culverts to pass fish. Hopefully, the presented findings and design procedures will resolve some of the current disagreements and problems associated with providing fish passage at stream culverts.

EVALUATION PROCEDURES

As stated above, the study consisted of a WFLHD field survey, the ODFW questionnaires, and a WFLHD design analysis of the culvert's fish passage capability. For their study, WFLHD placed the existing culverts into four classes of fish passage facilities. The four classes included the following:

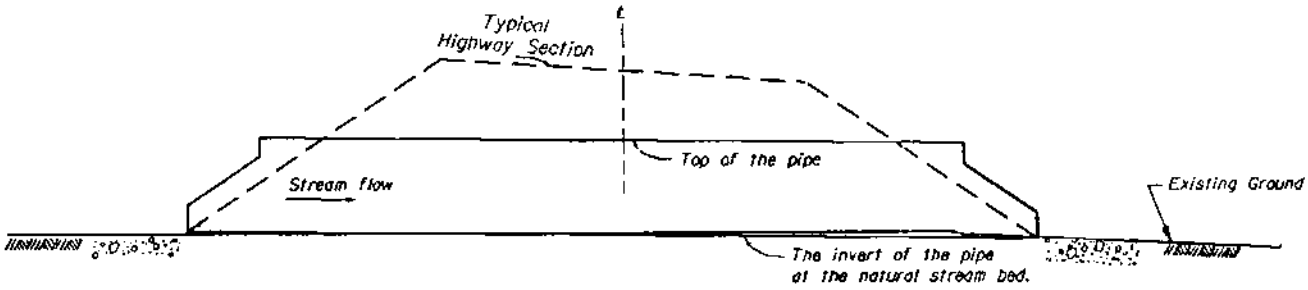
1. Pipes and pipe-arches with no special provisions for fish passage.

2. Pipes and pipe-arches with special provisions for fish passage. The special provisions primarily include baffles and fish ladder systems.

3. Pipes and pipe-arches with natural stream beds. This culvert type includes pipes and pipe-arches with their inverts set below the natural stream bed slope. Normally, the installer of the culvert will cover the invert with native stream bed material. Thus, the culvert will have a natural stream bed throughout its length.

4. Arches. The arch culvert typically consists of a half section of pipe with concrete or metal footings for foundation support. Since the footing system allows the culvert to span the stream channel width, the culvert will have a natural stream bed throughout its length like the culverts just described in Class 3.

Examples of these four classes are illustrated in Figure 1.



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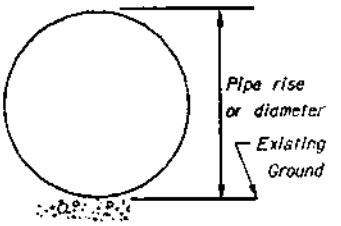
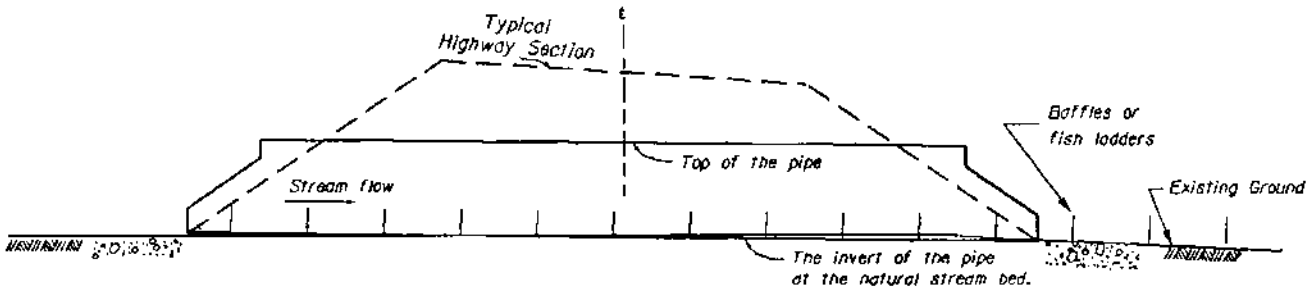


Section

CLASS 1

(PIPE AND PIPE-ARCHES WITH NO SPECIAL FEATURES)



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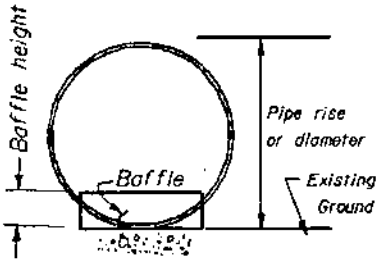
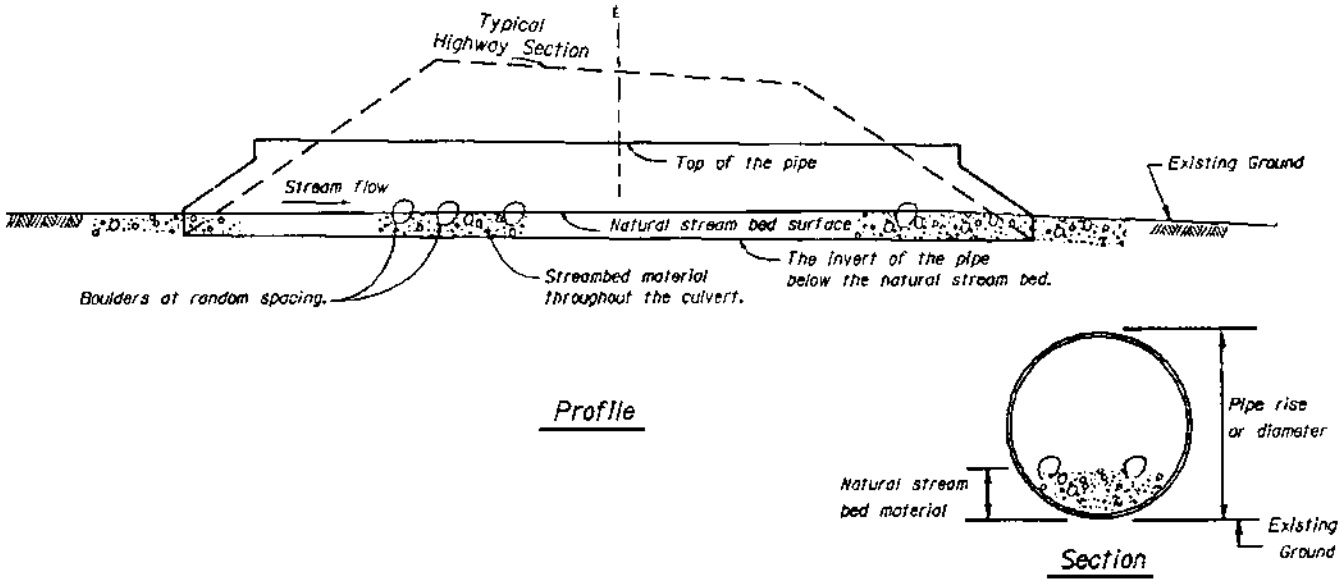


Section

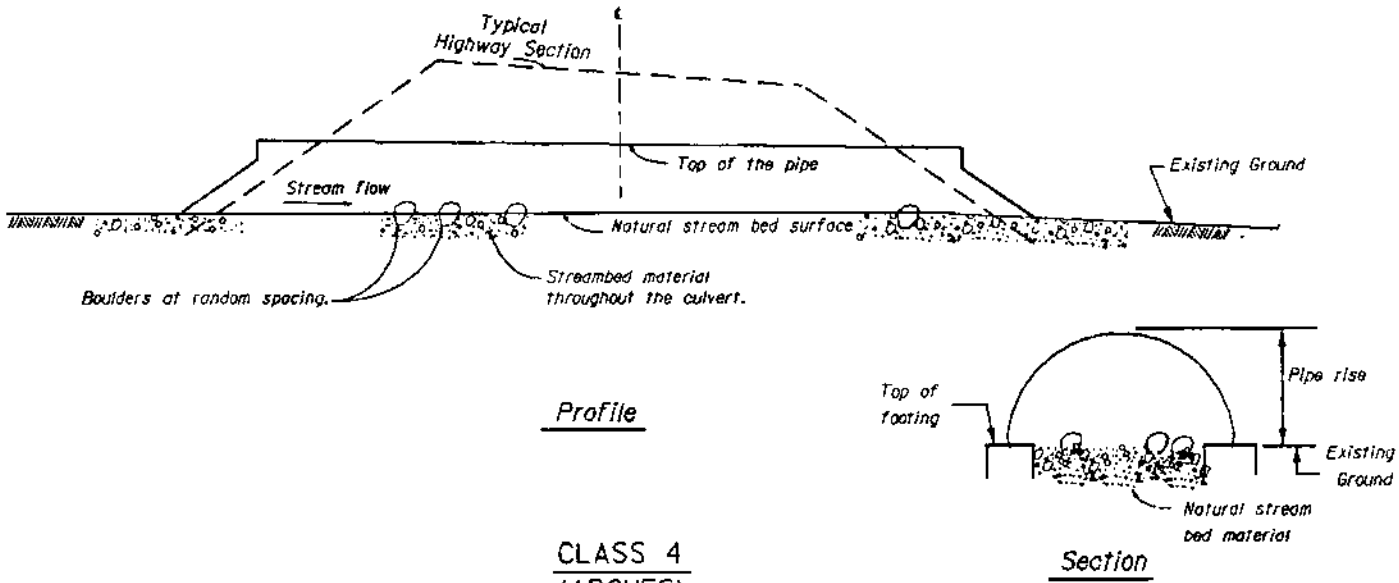
CLASS 2

(PIPE AND PIPE-ARCHES WITH SPECIAL FEATURES)

FIGURE 1. FOUR CLASSES OF CULVERTS



CLASS 3
(PIPE AND PIPE-ARCHES WITH NATURAL STREAM BEDS)



CLASS 4
(ARCHES)

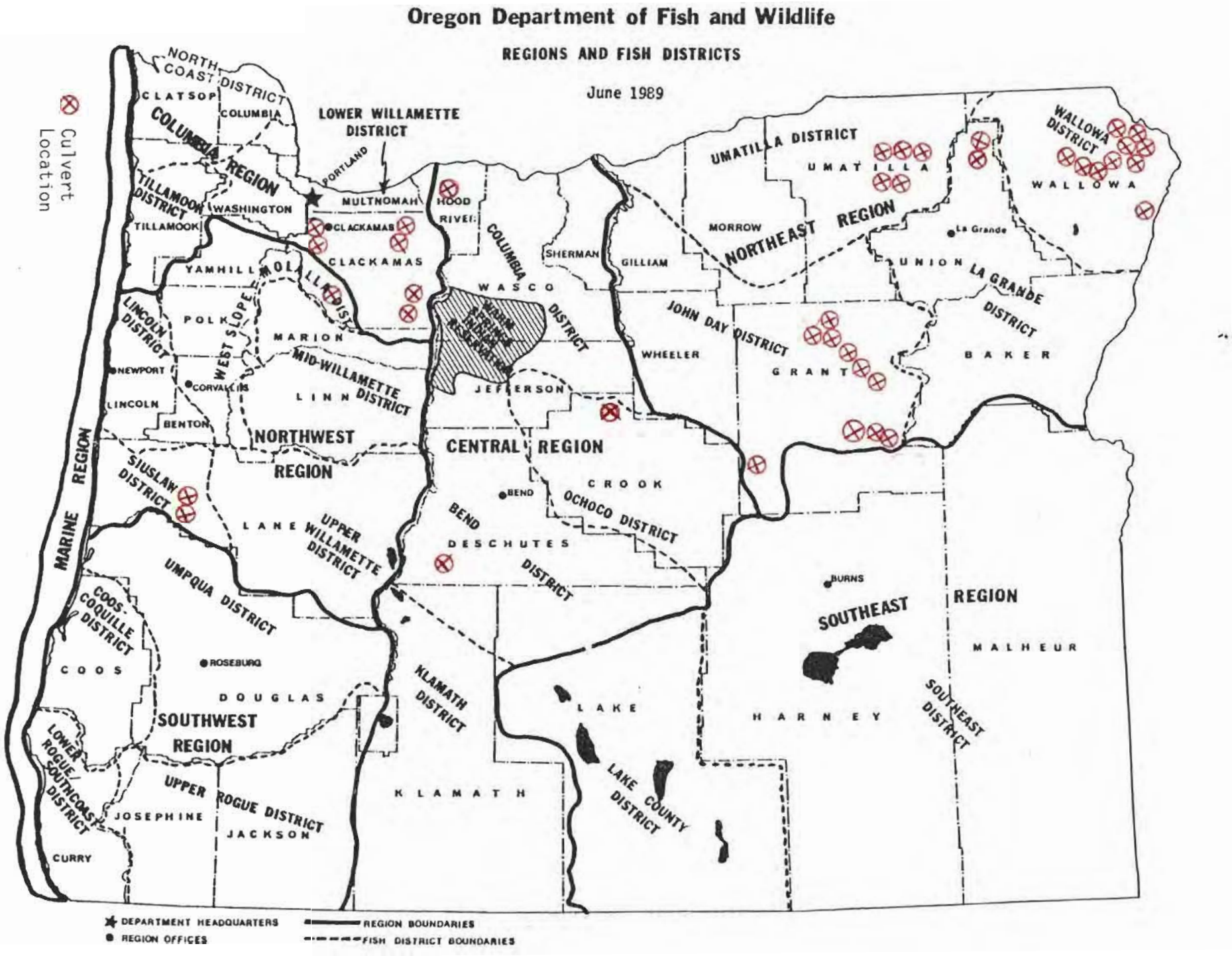
FIGURE 1. FOUR CLASSES OF CULVERTS
(CONTINUED)

WFLHD contacted each of the 23 ODFW District Fishery Biologists for a list of culverts that fit the above classes. However, WFLHD emphasized the culverts with a natural stream bed as the primary target of its study.

From the responses of the ODFW District Fishery Biologists, WFLHD targeted 65 culverts for the survey. Due to funding and time constraints, WFLHD reduced the number of culverts for their study to 48. After completing the field survey of the 48 culverts, WFLHD sent about 40 questionnaires to the respective fishery biologists for an evaluation of each culvert's passage capability.

Based upon the WFLHD data and the ODFW questionnaires, WFLHD compiled a final list of stream culverts for fish passage analysis. The list included six culverts with no special features for fish passage, six culverts with special features for fish passage, nine pipe and pipe-arches with natural stream beds, and 18 open bottom arches. Thus, the final list included a total of 39 stream culverts. Figure 2 shows the approximate locations of these 39 culverts.

For the 39 culverts, WFLHD collected field data that included the natural stream cross sections, the culvert dimensions and cross sections, the culvert types, and the types and dimensions of special features such as baffles and fish ladders. WFLHD also collected data on the locations and dimensions of culvert outlet scour and the locations and dimensions of any natural or manmade appurtenances such as log jams, adjacent culverts, and adjacent streams that may influence fish passage at the culvert site. Finally, they collected data on the gradation of the stream bed material and took



LOCATION MAP

representative photographs of the culvert and its surrounding stream environment. Appendix A contains the checklist for obtaining the WFHLD survey data.

ODFW Criteria

To complement the WFLHD field data, the ODFW District Fishery Biologists rated each selected culvert site for its respective fish passage capabilities. WFLHD asked the ODFW personnel to provide the following information for each culvert site:

1. Type and condition of species. For example, many of the culvert locations support coho salmon, winter steelhead, and resident trout. Also, some of the culvert locations were important to the development of juvenile fish as well as the passage of adult fish.

2. Importance of installation to subject species. The ODFW personnel rated each location as either critical, moderate, or noncritical to the local or migratory fishery.

3. Evaluation of installation. The ODFW personnel rated each location as either good, fair, or poor in its capability to pass fish.

In addition, the ODFW provided comments related to specific aspects of the culvert (i.e., "large drop at the outlet is an obstruction to upstream migration"). Appendix B contains the forms with the completed ODFW evaluations.

WFLHD Criteria

Using the field survey and the ODFW information, WFLHD analyzed and rated each culvert for its overall physical condition and its compatibility with the local stream environment. WFLHD used seven criteria. These criteria include the culvert condition, the culvert capacity, type of culvert foundation, condition of foundation, outlet scour, culvert stream bed surface, and the culvert hydraulics versus natural stream hydraulics. The culvert evaluation criteria were treated as follows:

1. Culvert condition. Based upon their field observations, WFLHD rated the overall physical condition of the culvert as either good, fair, or poor. If the culvert did not exhibit signs of roadway overtopping, foundation scour, barrel buckling, inlet or outlet damage, or any other defects that would make the culvert unserviceable, then they rated the culvert as good. If the culvert exhibited one of these defects, then they rated the culvert as fair. If the culvert exhibited more than one defect or if one defect was so severe that the culvert was highly susceptible to failure (i.e., excessive foundation scour), then they rated the culvert as poor. In general, this rating shows the culvert's ability to service the transportation system it serves.

2. Culvert capacity. Using the 50-year flood frequency, WFLHD determined the inlet headwater to pipe diameter ratio for each culvert. If the culvert was not circular, then they substituted the culvert rise for the pipe diameter. If the HW/R ratio was less than or equal to 1.0, they rated the culvert as good. If the HW/R ratio was greater than 1.0 but

less than or equal to 1.5, they rated the culvert as fair. For ratios greater than 1.5, they rated the culvert as poor. In general, this rating shows the chance of roadway overtopping during a major flood event. This rating also indirectly shows the constriction of the culvert upon the natural stream flow (i.e., HW/R ratio greater than 1.0). If a culvert constricts the natural channel too much, it may induce high inlet velocities that impede the passage of fish.

3. Type of culvert foundation. Footings or surrounding materials in the form of a closed loop (i.e., ring compression) normally support the culvert. WFLHD found the culverts in the study to be either "open" or "closed." They further found that either concrete or metal footings supported the open or arch culverts. They used this information in the evaluation of the other criteria.

4. Condition of foundation. Based upon their field observations, WFLHD rated the condition of the culvert foundation as good, fair, or poor. For a closed culvert, they rated the culvert as good if there was little evidence or chance that the culvert would settle or collapse. In this case, the culvert had good foundation materials and the adjacent stream flow was not likely to remove these materials. For an arch or open culvert, if nonerosive material supported the footings (i.e., bedrock), then they rated the culvert foundation as good. If the installer located the footings a reasonable distance below the expected scour depth, then they also rated the culvert foundation as good.

For both the closed and open culverts, WFLHD rated the foundations as fair if there was a chance of foundation failure during a major flood event or the culvert already exhibited slight signs of foundation failure. If the culvert foundation had already exhibited significant settlement, then they rated the foundation as poor. Also, if the footings exhibited either signs of undermining due to stream flow or were highly susceptible to scour failure during a minor to major flood event, then they rated the foundation as poor. In general, if they rated the culvert foundation as poor, this could significantly lower the rating of the culvert's overall condition.

5. Outlet scour. Based upon their field observations, WFLHD rated the culvert outlet scour condition as either severe, moderate, or negligible. If the scour depth was 1.5 feet or greater, they rated the outlet scour as severe. If the scour depth was less than 1.5 feet but greater than 0.5 feet, they rated the culvert outlet scour as moderate. If the scour depth was less than or equal to 0.5 feet, they rated the culvert outlet scour as negligible. WFLHD measured the scour depth at the culvert locations during low flow periods. Therefore, the actual outlet scour depths during flood events is probably much greater.

In general, this criteria shows whether or not a significant difference in elevation will develop between the culvert end and the natural stream bed located just downstream. The reader should not confuse this item with natural lowering of the stream bed over time and space (i.e., degradation). Nor should the reader confuse this item with the scour of

natural stream bed materials that may occur within the culvert barrel due to flood events.

6. Culvert stream bed surface. The stream bed surface at a culvert normally consists of the culvert barrel material (i.e., metal or concrete) or natural stream bed materials. The term natural stream bed materials includes materials native to the area or any other materials that would provide flow or sediment characteristics native to the area (i.e., clays, silts, sands, gravel, cobbles, boulders). This item is important for determining the barrel velocities and the scour potential within the culvert area. In general, a natural stream bed surface should generate hydraulic and sedimentation conditions compatible with the natural stream environment.

7. Culvert hydraulics versus natural stream hydraulics. Using the 2-year flood and the 50-year flood, WFLHD computed the culvert barrel depths and velocities and the natural stream depths and velocities. If the barrel velocities did not exceed the natural stream velocities by more than 50 percent, they rated the culvert as being compatible. Otherwise, they rated the culvert as incompatible with the natural stream environment. In addition to the velocity criteria, they also subjectively considered the constriction of the culvert barrel and the culvert outlet scour in the compatibility rating.

Finally, WFLHD provided general comments related to specific aspects of the culvert installation (i.e., "the short culvert length permits fish to pass

upstream through the barrel despite high velocities"). These comments are included in Appendix B.

Design Analysis

To complete the final portion of the study, WFLHD used their design procedures for analyzing the hydrologic and hydraulic characteristics of each culvert. The following is a brief outline of the main steps in their analytical approach:

1. WFLHD determined the 2-year and 50-year flood values for each of the culvert sites. WFLHD typically uses the 2-year flood for checking the fish passage characteristics of the culvert. For the culvert's serviceability to the transportation system, they normally use the 50-year flood to check for roadway overtopping and inlet and outlet erosion. Since they found only one culvert site located near a gaging station, WFLHD used USGS regression equations to determine the flood peaks for each culvert (1)(2). Appendix C contains the hydrologic inputs and the computed values for the 2-, 5-, 10-, 25-, 50-, and 100-year flood for each culvert.

2. Using the computed flood values and the topographic data obtained from the field survey, WFLHD computed the depth and velocity values for a typical channel section at each culvert location. For the hydraulic analysis, they used Manning's equation for uniform flow to determine the depth and velocity values (3). Specifically, they used three primary

inputs: first, a trapezoidal section to define the irregular stream cross section; second, an energy slope based upon the average stream bed slope within the vicinity of the culvert; and third, a roughness value based upon the local stream bed materials (3).

Appendix D contains the hydraulic inputs and the computed depths and velocities for the 2- and 50-year flood for each culvert. For informational purposes, Appendix D also contains the computed stream bed shear stress and the computed particle diameter that the stream can transport. For both of these values, WFLHD used the tractive force and permissible shear stress methods (3)(4).

3. Once WFLHD determined the natural stream hydraulics for each culvert location, they analyzed the hydraulics of each culvert. WFLHD specifically computed the culvert headwater to pipe rise ratio, the culvert barrel velocity, and the culvert outlet velocity. They derived these output values using the typical culvert cross-section area, the culvert bed roughness, the culvert inlet configuration, the culvert bed slope, and downstream influences (i.e., log barriers, adjacent streams).

WFLHD computed the headwater to pipe rise ratio and the culvert outlet velocity using standard culvert design methods (i.e., inlet control, outlet control). FHWA publication "Hydraulic Design Series No. 5" contains the appropriate design methods (5). For the culvert barrel velocity, WFLHD normally computed this value using the same Manning's equation described above under Item 2. Of course, they substituted the culvert cross section, the culvert slope, and the culvert bed

roughness for the natural stream characteristics. Appendix E contains the culvert design sheets for each location. These sheets contain the above input and output values for the 2-year and 50-year floods.

4. After they completed the culvert hydraulics, WFLHD computed the outlet scour using the methods contained in FHWA publication "Hydraulic Engineering Circular No. 14" (6). The circular presents a method in chapter V for computing the outlet scour for clay size to fine gravel sized particles. Appendix F contains the stream bed gradations for each culvert site included in the WFLHD study. Appendix F shows the stream bed gradations to range from fine gravel to coarse gravel. For this reason, WFLHD used the method contained in chapter XI of Circular No. 14 to compute the outlet scour. They used this information to determine whether or not the field survey should have shown scour at the culvert outlet.

   Appendix G contains the input values and the corresponding computed scour depths for the 2-year and 50-year floods. Although WFLHD used both methods from Circular No. 14 to check for outlet scour, Appendix G contains only the results from the method presented in chapter XI. Specifically, WFLHD input the design discharge, the culvert outlet velocity, the culvert width, the stream bed particle size, and the tailwater depth at the culvert outlet. For the stream bed particle size,

they normally used the particle size of the gradation of such that 50 percent of the mixture is finer by weight. For the tailwater depth, they normally used the computed downstream channel depth from Manning's equation unless field conditions indicated other downstream controls (i.e., log weirs, flood waters from adjacent streams).

5. Finally, WFLHD compared stream channel velocities, culvert barrel velocities, and the stream bed material gradations to the maximum permissible velocities that will not cause erosion of the channel body. For their study, WFLHD used the Fortier and Scobey maximum permissible velocity values (3). They used this information primarily for rating the foundation condition of arches. For example, if the culvert footings were only 1 to 2 feet below the stream bed and the culvert velocities exceeded the maximum permissible velocities, then they rated the foundation condition lower than otherwise. However, they did not compute scour depths within the culvert because of insufficient information on the sediment transporting capability of each stream. Therefore, WFLHD used this parameter as a guide in their subjective evaluation of the foundation condition of arches.

RESULTS

Tables 1, 2, 3, and 4 summarize the WFLHD and ODFW evaluations for the fish passage study. Tables 5, 6, 7, and 8 summarize the primary hydraulic parameters used in the WFLHD evaluations. Based upon a review of these tables, WFLHD presents the following summary of the results:

1. ODFW personnel rated the arch as a good facility for passing fish (Table 1). ODFW personnel generally rated the pipes and pipe-arches with natural stream beds as good for fish passage (Table 2). The ODFW evaluators gave poor or fair ratings to the pipe and pipe-arches with special passage features (Table 3), while they gave mixed ratings to the pipes and pipe-arches with no special features (Table 4).

2. WFLHD personnel generally gave good ratings for the overall physical condition, the culvert capacity, and the foundation condition to pipes and pipe-arches with and without special features. WFLHD personnel also gave good ratings to pipes and pipe-arches with natural stream beds for the same criteria. While they gave fair or good ratings for the hydraulic capacity of arches, the WFLHD personnel gave poor or fair ratings for the arches' overall physical and foundation conditions.

3. WFLHD personnel generally rated outlet scour as negligible for arches and culverts with natural stream beds. Conversely, their ratings on outlet scour ranged from negligible to severe for culverts with and without special features.

TABLE 1. SUMMARY OF EVALUATIONS FOR ARCHES

STREAM NAME	REF. NO	SPAN FT	RISE FT	OVERALL CONDITION	CULVERT CAPACITY	FOUNDATION CONDITION	OUTLET SCOUR	HYDRAULIC COMPATIBILITY	PASSAGE CAPABILITY
Cool Creek	1-C	14.7	9.5	Poor	Fair	Fair	Negligible	Compatible	Good
Lost Creek	1-D	18.2	5.6	Fair	Good	Poor	Negligible	Compatible	Good
Little Looking Glass Creek	14-B	17.6	8.0	Fair	Good	Poor	Negligible	Incompatible	Good
Devil's Run Creek	D-6	10.2	4.5	Fair	Good	Poor	Negligible	Compatible	Good
Gumboot Creek	D-8	15.0	8.5	Fair	Good	Poor	Negligible	Compatible	Good
Elk Creek	15-D	13.9	6.1	Fair	Good	Poor	Negligible	Compatible	Good
Chesnimus Creek	15-E	11.0	5.7	Fair	Fair	Poor	Negligible	Compatible	Good
Crow Creek	15-F	12.8	5.0	Good	Poor	Good	Negligible	Compatible	Good
Ruby Creek	12-D	8.0	4.0	Good	Fair	Fair	Negligible	Compatible	Good
Big Creek	12-E	12.0	7.0	Poor	Fair	Poor	Moderate	Compatible	Good
Indian Creek	12-F	12.0	7.0	Poor	Fair	Poor	Moderate	Compatible	Good
Granite Creek	12-G	12.8	5.3	Fair	Good	Poor	Negligible	Compatible	Good
Granite Creek	12-H	13.1	6.8	Fair	Good	Poor	Negligible	Compatible	Good
Granite Creek	12-I	13.2	6.9	Poor	Good	Poor	Negligible	Compatible	Good
Marks Creek	11-A	18.0	8.8	Good	Good	Fair	Negligible	Compatible	Good
Lowe Creek	2-A	21.7	11.7	Fair	Good	Poor	Moderate	Compatible	Good
Haight Creek	7-A	18.2	8.9	Fair	Good	Fair	Negligible	Compatible	Good
Eames Creek	7-B	13.8	6.9	Fair	Fair	Fair	Negligible	Compatible	Good

TABLE 2. SUMMARY OF EVALUATIONS FOR PIPES AND PIPE-ARCHES WITH NATURAL STREAM BEDS

STREAM NAME	REF. NO	SPAN FT	RISE FT	OVERALL CONDITION	CULVERT CAPACITY	FOUNDATION CONDITION	OUTLET SCOUR	HYDRAULIC COMPATIBILITY	PASSAGE CAPABILITY
Newell Creek	1-B		14.0	Good	Good	Good	Negligible	Compatible	Good
Meacham Creek	13-A	12.8	14.0	Good	Good	Good	Negligible	Compatible	Fair
Meacham Creek	13-B		15.0	Good	Good	Good	Negligible	Compatible	Fair
Meacham Creek	13-C	14.0	15.0	Good	Good	Good	Negligible	Compatible	Fair
Meacham Creek	13-D	20.0	20.0	Good	Good	Good	Negligible	Compatible	Good
Middle Fork of Canyon Creek	12-B	13.5	8.5	Good	Good	Good	Negligible	Compatible	Good
Canyon Creek	12-C		10.0	Fair	Good	Good	Negligible	Compatible	Good
Sunflower Creek	12-J	17.3	10.0	Good	Good	Good	Negligible	Compatible	Good
Brown's Creek	10-A	12.6	9.4	Good	Good	Good	Negligible	Compatible	Good

TABLE 3. SUMMARY OF EVALUATIONS FOR PIPES AND PIPE-ARCHES WITH SPECIAL FEATURES

STREAM NAME	REF. NO	SPAN FT	RISE FT	OVERALL CONDITION	CULVERT CAPACITY	FOUNDATION CONDITION	OUTLET SCOUR	HYDRAULIC COMPATIBILITY	PASSAGE CAPABILITY
Mt. Scott Creek	1-A	10.0	8.0	Good	Good	Good	Severe	Incompatible	Poor
Mottet Creek	14-A	5.8	7.0	Good	Fair	Good	Negligible	Incompatible	Fair
Billy Creek	C-3	6.3	5.0	Good	Good	Good	Negligible	Incompatible	Fair-Poor
Camp Creek	B-2		8.0	Fair	Poor	Good	Severe	Compatible	Fair
Doe Creek	C-4	7.7	5.4	Good	Good	Good	Negligible	Incompatible	Fair-Poor
Poop Creek	2-B		4.0	Good	Good	Good	Moderate	Incompatible	Fair

TABLE 4. SUMMARY OF EVALUATIONS FOR PIPES AND PIPE-ARCHES WITH NO SPECIAL FEATURES

STREAM NAME	REF. NO	SPAN FT	RISE FT	OVERALL CONDITION	CULVERT CAPACITY	FOUNDATION CONDITION	OUTLET SCOUR	HYDRAULIC COMPATIBILITY	PASSAGE CAPABILITY
Polallie Creek	C-7	12.7	7.25	Good	Fair	Good	Moderate	Incompatible	Good
Tamarack Gulch	15-A	6.0	3.9	Good	Good	Good	Negligible	Incompatible	Good
South Fork Chesnimus Creek	15-B		6.7	Good	Good	Good	Moderate	Incompatible	Fair
Sheep Creek	13-E		7.0	Good	Good	Good	Negligible	Incompatible	Poor
Canyon Creek	12-A	12.6	8.1	Good	Fair	Good	Severe	Incompatible	Fair
Pine Creek	3-A		7.5	Fair	Fair	Good	Severe	Incompatible	Good

TABLE 5. SUMMARY OF PRIMARY HYDRAULIC PARAMETERS FOR ARCHES

STREAM NAME	REF. NO	SPAN FT	RISE FT	Q2 CFS	Q50 CFS	Q50 HW/R	Q2 Vch FPS	Q2 Vb FPS	Q2 Vb/Vch	Q50 Vch FPS	Q50 Vb FPS	Q50 Vb/Vch	Nch	Nb	Nch/Nb	S FT/FT	D50 FT	Q2 Scour FT	Q50 Scour FT
Cool Creek	1-C	14.7	9.5	145	365	1.1	4.3	4.6	1.1	5.5	6.3	1.1	.045	.045	1.0	.010	.17	0.0	0.0
Lost Creek	1-D	18.2	5.6	255	650	0.8	5.3	5.8	1.1	7.0	8.2	1.2	.045	.045	1.0	.014	.06	0.0	0.0
Little Looking Glass Creek	14-B	17.6	8.0	195	560	0.8	3.7	6.0	1.6	4.7	8.0	1.7	.045	.045	1.0	.016	.08	0.0	0.0
Devil's Run Creek	D-6	10.2	4.5	28	129	0.8	3.3	3.7	1.1	4.7	5.7	1.2	.040	.040	1.0	.014	.13	0.0	0.0
Gumboot Creek	D-8	15.0	8.5	142	444	0.6	4.4	5.8	1.3	5.9	8.2	1.4	.045	.045	1.0	.017	.21	0.0	0.0
Elk Creek	15-D	13.9	6.1	71	333	0.8	3.5	3.9	1.1	5.7	6.0	1.1	.045	.045	1.0	.010	.17	0.0	0.0
Chesnimus Creek	15-E	11.0	5.7	91	381	1.3	3.5	1.8	0.5	5.0	7.6	1.5	.040	.040	1.0	.001	.12	0.0	0.0
Crow Creek	15-F	12.8	5.0	135	603	2.1	5.0	5.4	1.1	7.4	10.2	1.3	.040	.040	1.0	.012	.04	0.0	2.1
Ruby Creek	12-D	8.0	4.0	40	165	1.1	4.5	5.9	1.3	7.2	8.5	1.2	.040	.040	1.0	.030	.05	0.6	1.8
Big Creek	12-E	12.0	7.0	230	725	1.5	8.3	10.8	1.3	12.1	14.7	1.2	.040	.040	1.0	.044	.19	3.9	7.7
Indian Creek	12-F	12.0	7.0	185	590	1.2	7.7	9.6	1.2	10.8	13.1	1.2	.040	.040	1.0	.034	.15	2.8	5.8
Granite Creek	12-G	12.8	5.3	75	290	0.8	4.8	4.9	1.0	6.8	7.2	1.1	.040	.040	1.0	.012	.13	0.0	0.0
Granite Creek	12-H	13.1	6.8	75	290	0.6	4.1	4.7	1.1	6.2	7.1	1.1	.045	.045	1.0	.015	.25	0.0	0.0
Granite Creek	12-I	13.2	6.9	95	350	0.5	6.4	6.2	1.0	9.0	9.0	1.0	.045	.045	1.0	.022	.17	0.0	1.2
Marks Creek	11-A	18.0	8.8	115	600	0.8	3.6	3.0	0.8	5.6	4.8	0.9	.040	.040	1.0	.003	.06	0.0	0.0
Lowe Creek	2-A	21.7	11.7	440	1160	0.7	9.7	10.5	1.1	12.1	14.7	1.2	.045	.045	1.0	.050	.13	2.8	7.2
Haight Creek	7-A	18.2	8.9	190	440	0.7	3.1	3.1	1.0	4.0	3.7	0.9	.040	.035	1.1	.002	.06	0.0	0.0
Eames Creek	7-B	13.8	6.9	280	640	1.1	3.9	4.0	1.0	5.0	7.4	1.5	.040	.035	1.1	.002			
Averages				155	484	1.0	5.0	5.5	1.1	6.9	8.4	1.2	.042	.042	1.0	.017	.13	0.6	1.5

TABLE 6. SUMMARY OF PRIMARY HYDRAULIC PARAMETER FOR PIPES AND PIPE-ARCHES WITH NATURAL STREAM BEDS

							Q2			Q50								Q2	Q50
STREAM NAME	REF. NO	SPAN FT	RISE FT	Q2 CFS	Q50 CFS	Q50 HW/R	Vch FPS	Vb FPS	Vb/Vch	Vch FPS	Vb FPS	Vb/Vch	Nch	Nb	Nch/Nb	S FT/FT	D50 FT	Scour FT	Scour FT
Newell Creek	1-B		14.0	95	275	0.4	3.6	4.0	1.1	5.0	6.0	1.2	.045	.045	1.0	.010	.01	0.0	0.0
Meacham Creek	13-A	12.8	14.0	75	500	0.6	3.8	4.8	1.3	6.6	7.6	1.2	.045	.045	1.0	.013	.06	0.0	0.0
Meacham Creek	13-B		15.0	95	625	0.6	4.3	5.2	1.2	7.3	8.0	1.1	.045	.045	1.0	.013	.08	0.0	0.0
Meacham Creek	13-C	14.0	15.0	95	625	0.5	5.1	6.0	1.2	8.9	9.4	1.1	.045	.045	1.0	.020	.13	0.0	1.0
Meacham Creek	13-D	20.0	20.0	95	625	0.5	4.9	5.3	1.1	8.4	8.7	1.0	.045	.045	1.0	.014	.13	0.0	0.9
Middle Fork of Canyon Creek	12-B	13.5	8.5	110	350	0.8	4.4	6.2	1.4	5.9	8.6	1.5	.045	.045	1.0	.022	.05	0.0	0.6
Canyon Creek	12-C		10.0	105	345	0.7	5.7	6.5	1.1	8.1	9.0	1.1	.040	.040	1.0	.018	.09	0.1	1.2
Sunflower Creek	12-J	17.3	10.0	135	485	0.6	4.9	7.0	1.4	7.4	10.8	1.5	.045	.045	1.0	.037	.21	0.3	3.0
Brown's Creek	10-A	12.6	9.4	100	415	0.8	3.2	4.2	1.3	4.7	6.1	1.3	.040	.035	1.1	.005	.04	0.0	0.0
Averages				101	472	0.6	4.4	5.5	1.2	6.9	8.2	1.2	.044	.043	1.0	.017	.09	0.0	0.7

TABLE 7. SUMMARY OF PRIMARY HYDRAULIC PARAMETERS FOR PIPES AND PIPE-ARCHES WITH SPECIAL FEATURES

							Q2			Q50								Q2	Q50
STREAM NAME	REF. NO	SPAN FT	RISE FT	Q2 CFS	Q50 CFS	Q50 HW/R	Vch FPS	Vb FPS	Vb/Vch	Vch FPS	Vb FPS	Vb/Vch	Nch	Nb	Nch/Nb	S FT/FT	D50 FT	Scour FT	Scour FT
Mt. Scott Creek	1-A	10.0	8.0	110	330	0.7	4.7	11.0	2.3	6.6	15.0	2.3	.045	.015	3.0	.017	.06	4.3	8.0
Mottet Creek	14-A	5.8	7.0	125	375	1.4	6.7	16.4	2.4	9.0	20.5	2.3	.045	.024	1.9	.057	.17	8.5	13.3
Billy Creek	C-3	6.3	5.0	45	197	0.8	4.5	8.0	1.8	6.5	11.7	1.8	.040	.024	1.7	.023	.08	0.0	0.5
Camp Creek	B-2		8.0	153	619	2.0	6.8	8.4	1.2	10.1	13.8	1.4	.040	.040	1.0	.025	.06	1.7	6.6
Doe Creek	C-4	7.7	5.4	25	116	0.7	3.9	6.5	1.7	6.5	11.0	1.7	.040	.024	1.7	.026	.08	0.0	0.0
Poop Creek	2-B		4.0	10	35	0.6	2.9	8.0	2.8	4.8	11.5	2.4	.045	.024	1.9	.059	.17	1.1	4.5
Averages				78	279	1.0	4.9	9.7	2.0	7.3	13.9	2.0	.043	.025	1.9	.035	.10	2.6	5.5

TABLE 8. SUMMARY OF PRIMARY HYDRAULIC PARAMETERS FOR PIPES AND PIPE-ARCHES WITH NO SPECIAL FEATURES

							Q2			Q50								Q2	Q50
STREAM NAME	REF. NO	SPAN FT	RISE FT	Q2 CFS	Q50 CFS	Q50 HW/R	Vch FPS	Vb FPS	Vb/Vch	Vch FPS	Vb FPS	Vb/Vch	Nch	Nb	Nch/Nb	S FT/FT	D50 FT	Scour FT	Scour FT
Polallie Creek	C-7	12.7	7.25	425	1090	1.3	9.2	21.5	2.3	11.6	29.5	2.5	.045	.015	3.0	.043	.25	13.5	22.9
Tamarack Gulch	15-A	6.0	3.9	11	55	0.7	2.9	5.5	1.9	4.7	9.6	2.0	.040	.024	1.7	.033	.02	0.9	3.3
South Fork Chesnimus Creek	15-B		6.7	23	107	0.6	3.6	8.0	2.2	5.3	12.5	2.4	.040	.024	1.7	.030	.06	2.3	5.6
Sheep Creek	13-E		7.0	20	150	0.7	4.5	9.0	2.0	9.1	16.0	1.8	.050	.024	2.1	.053	.25	1.4	8.4
Canyon Creek	12-A	12.6	8.1	215	675	1.2	6.8	11.1	1.6	9.1	15.6	1.7	.045	.024	1.9	.020	.07	4.3	8.1
Pine Creek	3-A		7.5	250	665	1.5	8.1	13.7	1.7	10.2	17.1	1.7	.045	.024	1.9	.026	.13	6.8	10.5
Averages				157	457	1.0	5.9	11.5	2.0	8.3	16.7	2.0	.044	.023	2.1	.034	.13	4.9	9.8

4. WFLHD personnel rated the hydraulic compatibility of arches and culverts with natural stream beds as compatible. However, they rated the hydraulic compatibility of culverts with and without special features as incompatible.

5. For the 50-year flood (Q50), Tables 5 through 8 show an average headwater to rise ratio of 1.0 for all culvert classes except for the pipe and pipe-arches with natural stream beds. For these culverts, the headwater to rise ratio is 0.6.

6. For the 2-year flood (Q2), Tables 5 and 6 show the culverts with natural stream beds and the arches have culvert barrel velocities that on average exceed the natural stream channel velocity by 10 to 20 percent. According to Tables 7 and 8, the culvert barrel velocity is twice the natural stream channel velocity for the culverts with and without special passage features.

7. For the 2-year flood, Tables 5 and 6 show the average computed outlet scour for culverts with natural stream beds and arches as 0.0 foot and 0.6 foot, respectively. According to Tables 7 and 8, the culverts with and without special features have average computed outlet scours of 4.9 feet and 2.6 feet, respectively.

8. For the 2-year flood, Tables 5 through 8 show the average stream channel velocity to be 4.4 feet per second to 5.9 feet per second for the four culvert classes. For the 50-year flood, the stream channel velocities

averaged from 6.9 feet per second to 8.3 feet per second. For comparison, Table 9 and Figure 3 present fish speeds for various species and stream conditions (10). A comparison of these values to the computed barrel velocities illustrates that the arches and the culverts with natural stream beds provide the best fish passage facilities for various fish species.

For informational purposes, Figures 4 through 8 show the graphical relationships for several of the above key parameters. Specifically, Figures 4 through 6 show the relationship between fish passage capability and headwater to culvert rise ratio, fish passage capability and culvert barrel velocity to stream channel velocity ratio, and fish passage capability and computed outlet scour, respectively. Figure 7 shows the scatter of data for culvert foundation condition versus fish passage capability. Finally, Figure 8 shows the relationship between the observed outlet scour and the computed outlet scour.

Using simple linear regression analysis, Figures 5 and 8 show the strongest statistical relationships occur between fish passage ratings and the barrel/channel velocity ratio and between the observed outlet scour ratings and the computed outlet scour. Conversely, Figure 4 shows little or no relationship between the fish passage ratings and the headwater to rise ratio, while Figure 6 shows a weak relationship between the computed outlet scour and the fish passage capability of the culvert.

TABLE 9.

Fish Speeds of Average Size Adult Salmon and Steelhead Trout, Bell (1973).

Specie	Fish Speed (fps) Sustained[b]	Prolonged[b]	Burst
Steelhead	0-4.6	4.6-13.7	13.7-26.5
Chinook	0-3.4	3.4-10.8	10.8-22.4
Coho	0-3.4	3.4-10.6	10.6-21.5
Sockeye	0-3.2	3.2-10.2	10.2-20.6
Pink & Chum[a]	0-2.6	2.6-7.7	7.7-15.0

[a] Pink and Chum salmon values estimated from leap heights of 3 to 4 feet at waterfalls.

[b] Called cruising and sustained, respectively, in Bell (1973).

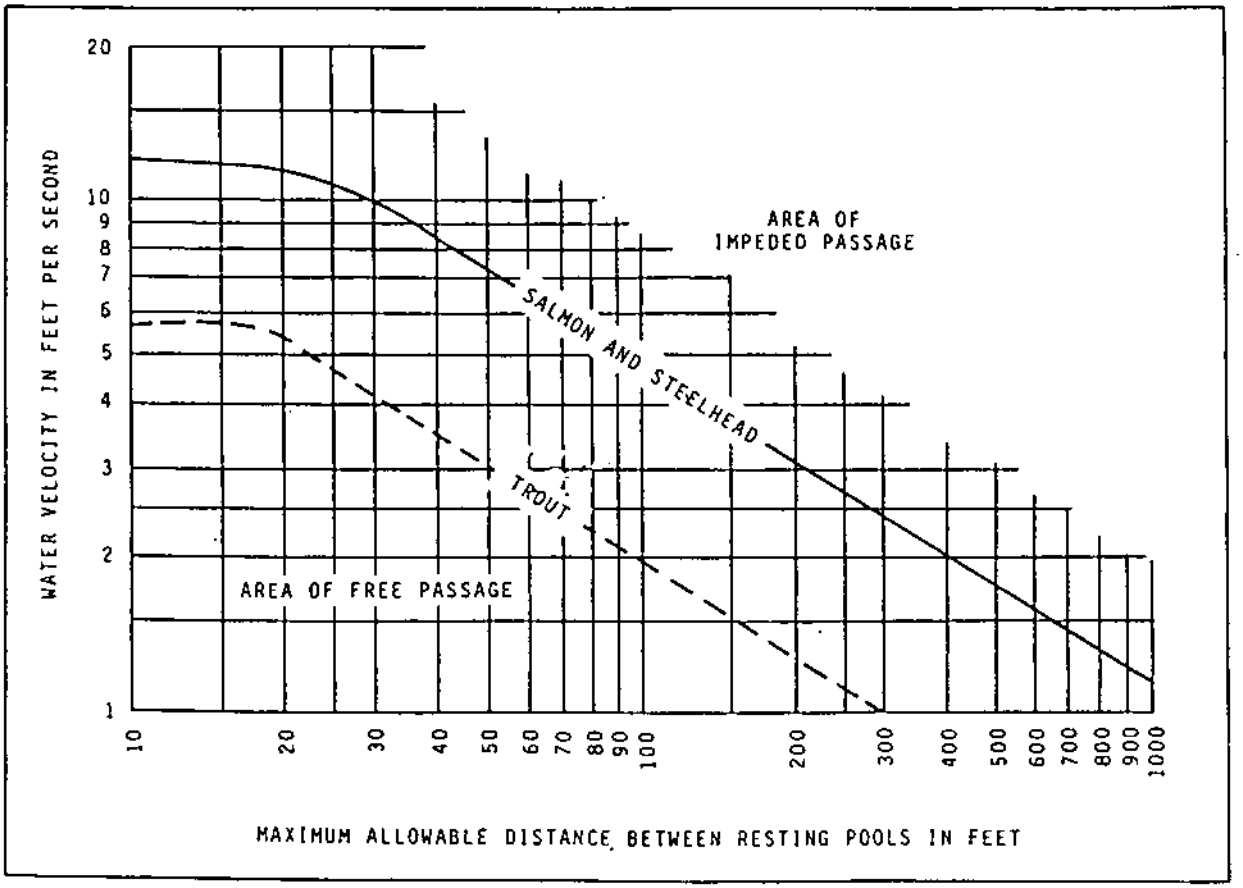


FIGURE 3. Swimming performance of salmon and trout from Evans and Johnston (1980). Curve developed by Ziemer, State of Alaska, Department of Fish and Game.

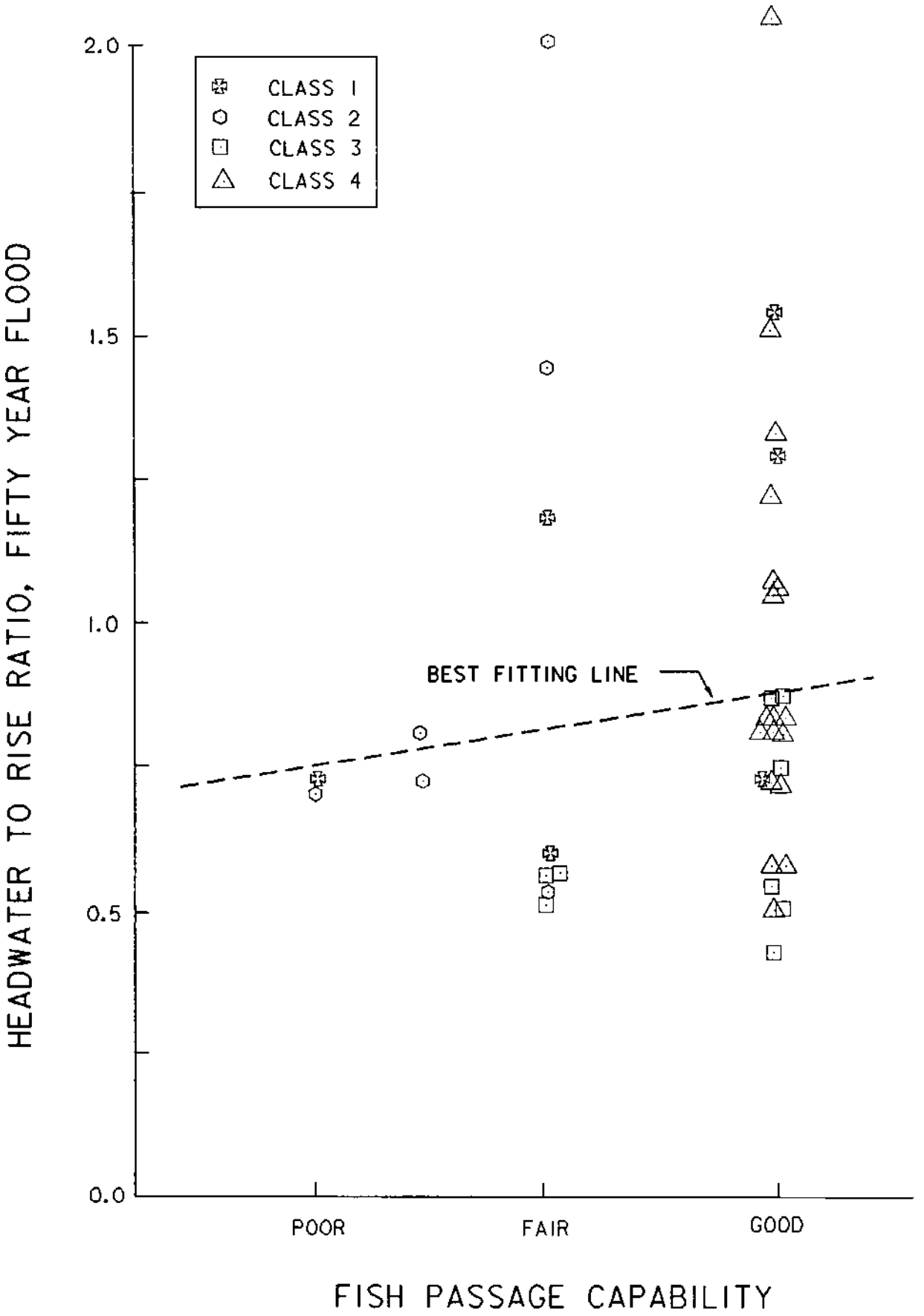

CLASS 1
CLASS 2
CLASS 3
CLASS 4
BEST FITTING LINE
2.0
1.5
1.0
0.5
0.0
HEADWATER TO RISE RATIO, FIFTY YEAR FLOOD
POOR
FAIR
GOOD
FISH PASSAGE CAPABILITY

FIGURE 4

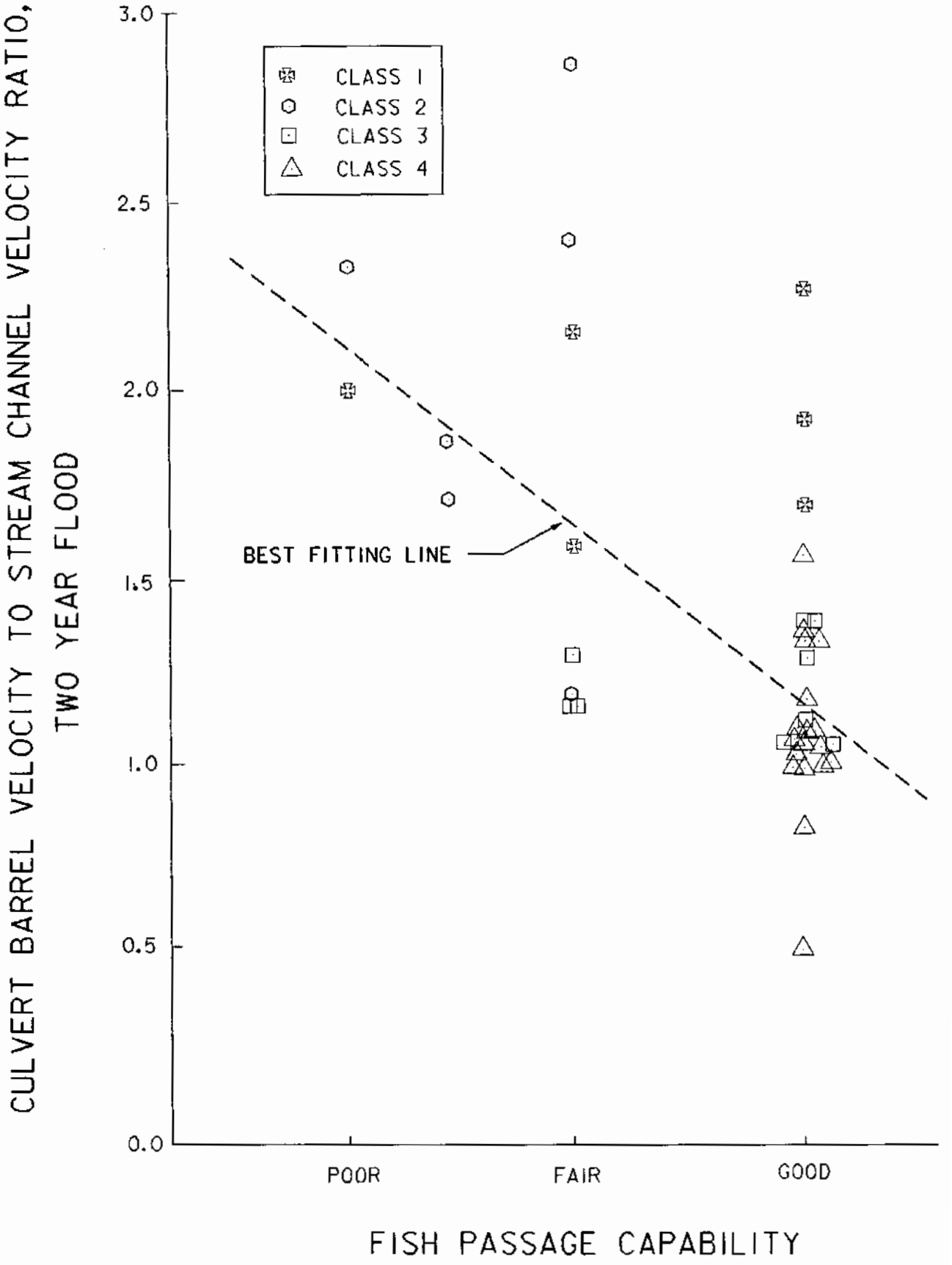

CULVERT BARREL VELOCITY TO STREAM CHANNEL VELOCITY RATIO, TWO YEAR FLOOD
3.0
2.5
2.0
1.5
1.0
0.5
0.0
CLASS 1
CLASS 2
CLASS 3
CLASS 4
BEST FITTING LINE
POOR
FAIR
GOOD
FISH PASSAGE CAPABILITY

FIGURE 5

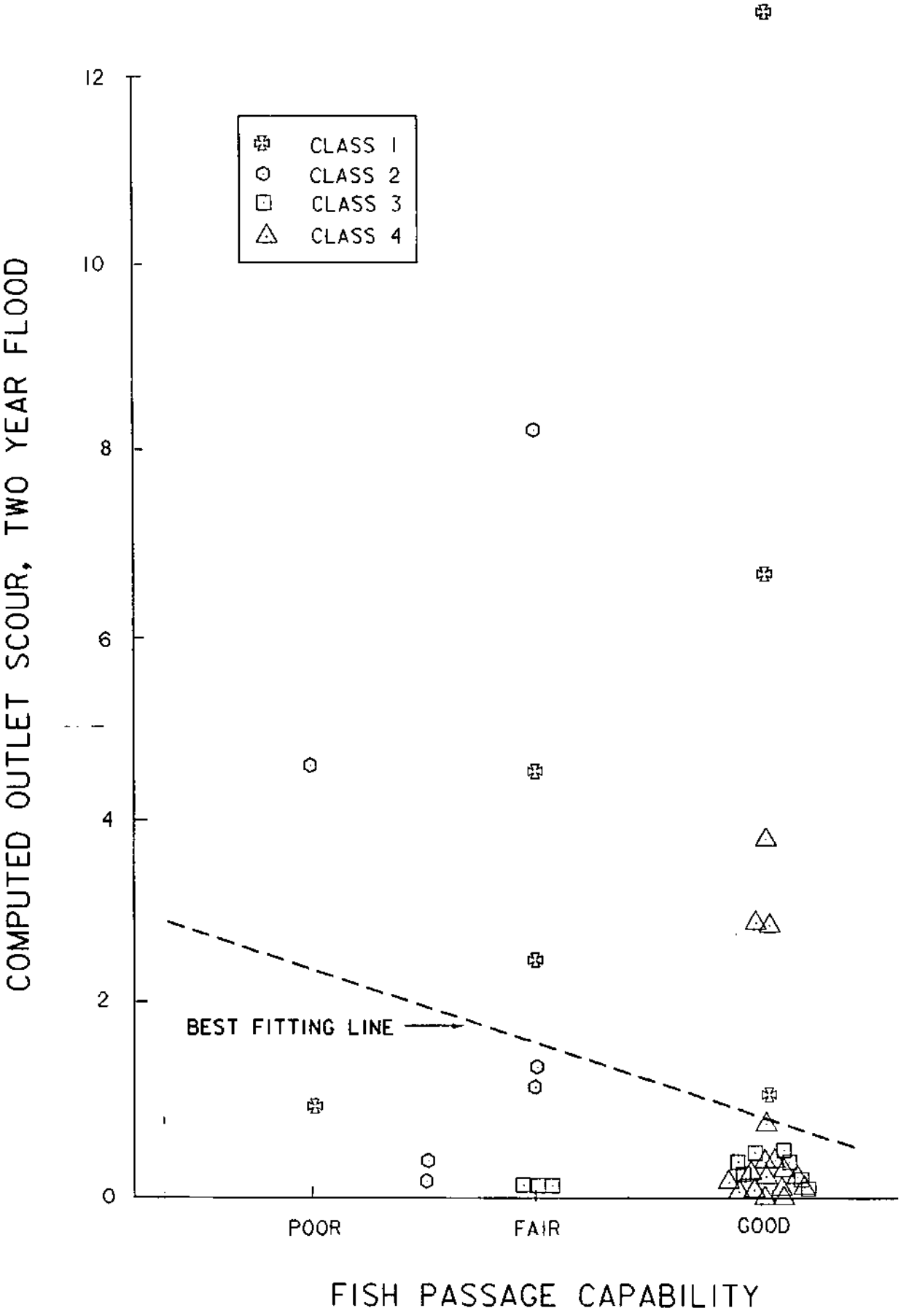

CLASS 1
CLASS 2
CLASS 3
CLASS 4
BEST FITTING LINE
COMPUTED OUTLET SCOUR, TWO YEAR FLOOD
12
10
8
6
4
2
0
POOR
FAIR
GOOD
FISH PASSAGE CAPABILITY

FIGURE 6

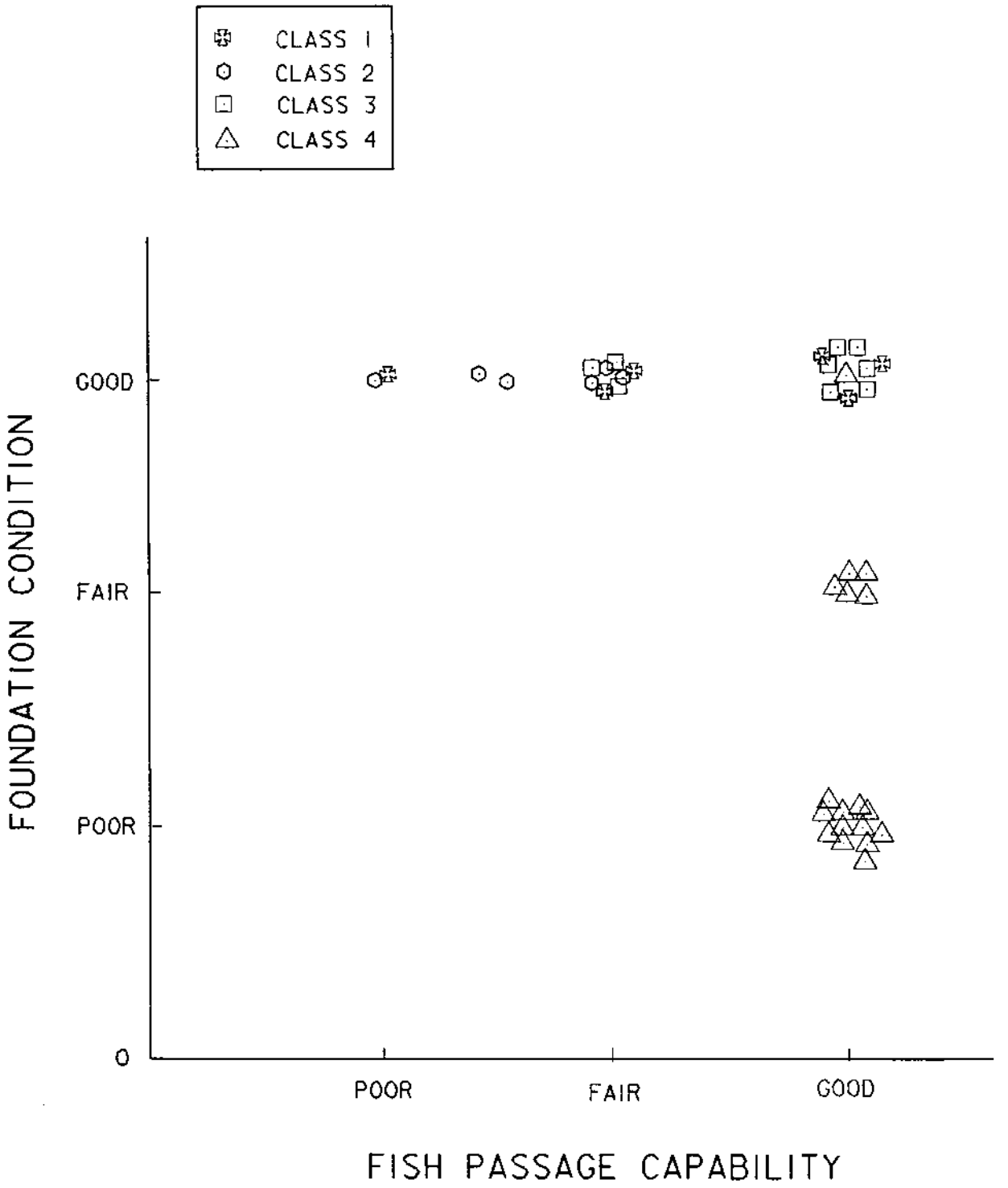

CLASS 1
CLASS 2
CLASS 3
CLASS 4
FOUNDATION CONDITION
GOOD
FAIR
POOR
0
POOR
FAIR
GOOD
FISH PASSAGE CAPABILITY

FIGURE 7

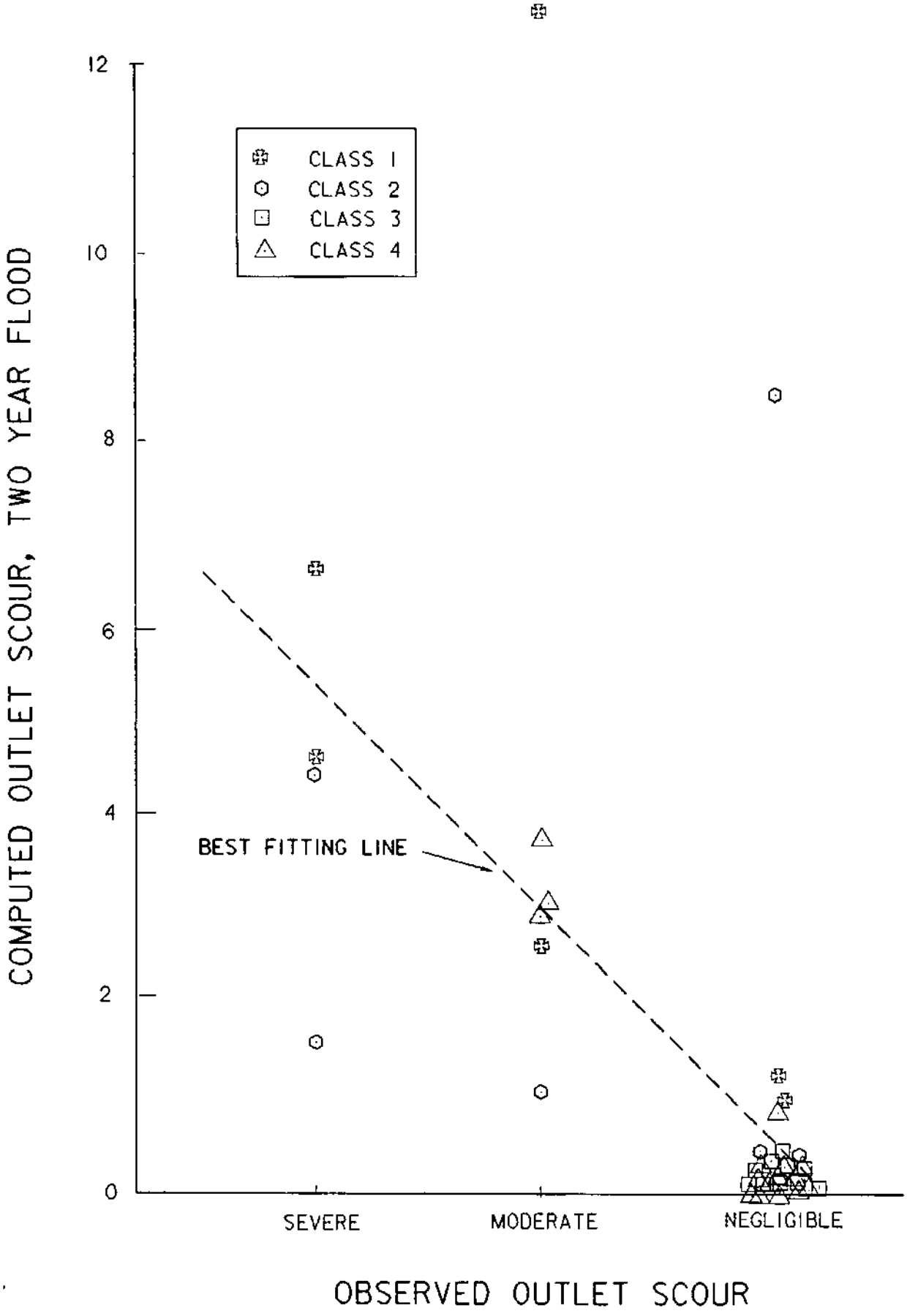

CLASS 1
CLASS 2
CLASS 3
CLASS 4
BEST FITTING LINE
COMPUTED OUTLET SCOUR, TWO YEAR FLOOD
0
2
4
6
8
10
12
SEVERE
MODERATE
NEGLIGIBLE
OBSERVED OUTLET SCOUR

FIGURE 8

CONCLUSIONS

Based upon the information in the tables and appendices, the arches and the pipe and pipe-arches with natural stream beds are the best fish passage culverts. Also, the tables and appendices show that the WFLHD design analysis provides a good approach for rating the fish passage capabilities of the culverts. For example, the WFLHD analysis shows that the arches and culverts with natural stream beds should have barrel velocities comparable to the natural stream velocities. Furthermore, the analysis shows that outlet scour for these culverts should not be a problem. Since unnaturally high barrel velocities and outlet scour "holes" are normally the major impedances to fish passage at culvert sites, proper analysis of these items should insure a proper fish passage design (7).

Conversely, the ODFW ratings and the WFLHD survey and analysis show that the culverts with and without special features provide only fair fish passage characteristics. According to WFLHD analysis, these culverts are hydraulically incompatible with the local stream environment. However, some of the culverts had mitigating features such as short lengths and downstream influences which allowed the fish to migrate upstream through the culvert (see Figure 1)(10). On the other hand, special features such as downstream ladder or weir systems in some instances became an impedance to fish passage during low flows. Thus, the culvert designer should analyze the special features such as baffles and downstream fish ladders for a variety of flow conditions. Also, these systems may require periodic maintenance.

Finally, WFLHD recommends the culvert designer use pipe and pipe-arches with natural stream beds instead of arches. With only a few exceptions, the installer could have placed a pipe or pipe-arch with a natural stream bed surface instead of the arch. However, if the installer can place the arch footings on bedrock or below the expected scour depth with proper structural support, then the arch may be a viable alternative. For their survey, WFLHD rated nearly all the arch foundations as poor or fair because of shallow footings placed on erosive material. As stated earlier, the stream velocities for the 2-year flood ranged from 4 to 6 fps, while the velocities for the 50-year flood ranged from 6 to 8 fps. Using the Fortier and Scobey maximum erosive velocities for gravel beds, the 2-year flood to 50-year floods induce erosive velocities within the arch barrels. Thus, the arches with shallow footings on erosive materials (i.e., silt, sand, gravel) are highly susceptible to scour and final foundation failure during a large flood.

Design Procedures

Based upon the above, WFLHD recommends the following design procedures for culvert fish passage designs:

1. The designer should select a stream discharge for analyzing the fish passage characteristics and a stream discharge for analyzing the serviceability of the culvert. As a minimum, the designer should select the 2-year and 50-year floods for the respective analyses. If possible, the designer should analyze the hydraulic characteristics for other

discharges such as 7-day highs and 7-day lows. Preferably, the designer should rate the hydraulic conditions of the stream and culvert for a wide variety of flow conditions (8).

2. Using the topographic data of the stream site and the selected culvert size, the designer should determine the pipe headwater-to-rise ratio for each of the selected discharges. Also, the designer should determine the culvert barrel depth and velocity and the natural stream channel depth and velocity for each of the same discharges. Concurrently, the designer should determine the culvert outlet depth and velocity and the corresponding culvert outlet scour. Finally, the designer should compare the computed stream channel and culvert depths and velocities against the maximum permissible values for stream erosion. For this analysis, WFLHD recommends the methods in the "Design Analysis" section of this report (i.e., USGS regression equations, FHWA HDS No. 5 and HEC 14).

Design Criteria

To aid in the above design process, WFLHD recommends the following culvert selection criteria:

1. The culvert headwater-to-rise ratio should not exceed 1.0. As a minimum, this criteria should be applicable to the discharge the designer selects for analyzing the serviceability of the culvert (i.e., 50-year flood). This item should insure that the culvert inlet does not excessively constrict the stream. Thus, this will reduce the chance of upstream

debris depositions and blockages and high inlet velocities that may impede fish passage.

2. The culvert barrel velocity should not exceed the natural stream channel velocity by more than 25 percent. As a minimum, this criteria should be applicable for discharges having a flood magnitude of 2 years or less. Ideally, the culvert barrel flow depths and velocities should match those of the natural stream channel as close as possible. However, natural streams may experience fluctuations in velocities as large as 50 percent from one stream section to the next for the same discharge. Thus, this criteria should insure reasonable passage of fish under most normal flow conditions.

3. The culvert outlet scour should not exceed 0.5 foot. As a minimum, this criterion should be applicable for discharges having a flood magnitude of 2 years or less. Ideally, the outlet scour should be nearly zero foot. However, the outlet scour depth will decrease as the stream flow decreases. Thus, the designer should expect the actual outlet scour during normal flow conditions to be less than the computed value for the 2-year flood.

Installation Criteria

WFLHD recommends the following installation procedures for pipe and pipe-arches with natural stream bed surfaces:

1. For culverts 10 feet or less in equivalent diameter, the installer of the culvert should set the barrel invert a minimum of 12 inches to 24 inches below the natural stream bed slope. For culverts with equivalent diameters larger than 10 feet, the installer should place the culvert barrel a minimum of one fifth the culvert rise below the natural stream bed slope.

2. The installer should fill the culvert barrel with materials that are similar to the natural stream bed materials. This will insure a culvert barrel roughness comparable to the stream channel roughness. Tables 5 and 6 show the culvert velocity will be comparable to the natural stream velocity if the culvert barrel roughness, Nb, is comparable to the stream channel roughness, Nch.

   In some instances, the existing stream bed may consist of cohesive materials such as clays and silt. These materials may not be suitable for relocation into the culvert barrel due to a reduction in their cohesiveness during the installation. Instead, the installer should consider fine or coarse gravel for the culvert stream bed surface. Eventually, the culvert stream bed should reach a material composition comparable to the natural stream bed. This will occur as the stream

deposits clay and sand-size particles within the barrel during low flows and the stream transports the gravel size particles away during high flows.

Initially, during low flow periods, the stream flow could submerge into the stream bed gravel. This is likely to happen when the installer performs extensive excavation upstream and downstream of the culvert and directly underneath the culvert for foundation purposes. Although the stream bed should eventually "seal" itself with the deposition of finer materials, the installer should consider placing a nonpermeable barrier between the stream bed materials and the foundation materials. This action should reduce the potential of the stream flow to submerge.

3. The installer should place the culvert barrel materials described under Item 2. to match the original or local stream bed elevations. This should insure a bed slope through the barrel comparable to the local stream bed slope.

4. The installer should place the culvert barrel itself on as flat a slope as possible. In general, the installer should limit culvert barrel to a slope steepness of 2 percent. This criteria should encourage barrel deposition of new materials during low flows to replace existing materials transported away during high flows. If the installer must place the culvert barrel on a slope steeper than 2 percent, then the installer should consider placing baffles inside the barrel to retain the stream bed materials (9).

The installer should also consider the sediment transporting capability of the stream before deciding on the final slope of the culvert barrel. Furthermore, the installer should consider the depth of materials placed within the culvert and the culvert's impact upon the hydraulics (i.e., velocity) before a final decision. If the culvert bed material depth is more than the expected local scour depth, then the culvert barrel slope may be irrelevant to maintaining a natural stream bed material within the culvert. However, if the installer cannot meet these conditions, then the installer should consider flattening the culvert barrel slope.

5. If the installer cannot develop a culvert layout that matches the hydraulic design criteria, then the installer should consider placing small boulders within the culvert. The boulders should reduce the overall barrel velocities as well as create a velocity profile comparable to that of a natural stream. In general, a culvert velocity profile that varies similar to the natural stream profile may be more important than the overall barrel velocity. For example, most fish can travel against high water velocities for short distances as shown in Figure 2 and Table 9 (10). Thus, a series of small boulders within the culvert should reduce the chances that the fish will have to travel upstream through the culvert at sustained high speeds. If the installer places small boulders within the barrel, the installer should embed them into the culvert bed materials. To reduce the potential for debris collection, the boulders should not protrude more than 12 inches above the culvert bed surface.

6. If outlet scour is a possible problem, then the installer should place boulders just downstream from the culvert outlet. This should dissipate

the stream's energy and reduce the potential scour depth. However, if stream degradation downstream from the culvert is also a potential problem, then the whole culvert installation may require lowering to anticipate an overall lower stream bed surface. In other cases, the installer may eventually have to replace the culvert with a new culvert.

While the subject of fish passage will require more research, WFLHD believes that sufficient design methods exist to ensure that culverts can pass fish under normal flow conditions. Hopefully, this study supports this conclusion.

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15 "Appendix to a Hydraulic Evaluation of Fish Passage through Roadway Culvert in Alaska Data Report," RD-85-24A, Alaska Department of Transportation and Public Facilities, May 1985.

NO.	REFERENCE
16	"Determination of Seasonal, Frequency, and Durational Aspects of Stream Flow with Regard to Fish Passage through Roadway Drainage Structures," RD-85-06, Alaska Department of Transportation and Public Facilities, November 1984.
17	"Spawning Migration of Arctic Grayling through Poplar Grove Creek Culvert," RD-88-09, Alaska Department of Transportation and Public Facilities, March 1988.

APPENDICES TO

OREGON CULVERT

FISH PASSAGE SURVEY

October 1990

Western Federal Lands
Highway Division,
Federal Highway Administration

APPENDIX A

WFLHD FIELD DATA CHECKLIST

CHECKLIST FOR THE FIELD INVESTIGATION OF SELECTED OREGON CULVERTS

I. Stream Cross Sections

A. Location*

1. At the culvert outlet.

2. At the culvert inlet.

3. At the location which is most representative of the natural stream section below the culvert outlet (i.e., 50 to 200 feet d/s from the culvert outlet).

4. At the location which is most representative of the natural stream section above the culvert inlet (i.e., 50 to 200 feet v/s from the culvert inlet).

5. At the location of maximum culvert outlet scour.

B. Special Details - Elevations and Distances of the Following Features Should Be Obtained:

1. The edge of water.

2. The top and bottom of footings and walls that support the culvert.

3. The top and bottom of the culvert outlet and inlet.

4. High-water marks.

*Note: Measure distances between all cross sections.

II. Culvert Details

A. Size (i.e., pipe diameter or maximum span and maximum rise)

B. Type (i.e., structural plate pipe-arch, structural plate arch, corrugated metal pipe, structural plate pipe)

C. Material (metal or concrete)

D. Special Features

1. Baffles.

a. Typical spacing and size, typical layout, and type (wood or metal).

2. Footings, support walls, metal cross ties.

a. Typical size, typical layout, type (concrete or metal).

3. Outlet features (man-made).

a. Type (i.e., log barriers, pools, and weirs, gabion baskets), typical layout, typical size.

III. Special Stream Features

A. Culvert Outlet Scour

1. Maximum length and width of scour hole.

B. Deposition of Stream Bed Material Within the Culvert Barrel

1. Average depth, length, and width of deposited material.

C. Natural Barriers

1. Type (i.e., logs or rocks), typical size, typical layout (i.e., distance from culvert inlet or outlet).

D. Surface Velocity Through Culvert Barrel

E. Adjacent Streams and Man-Made Structures Which May Influence the Hydraulic Characteristics of the Culverted Stream

1. Distance and direction of adjacent streams and man-made structures from the culvert (i.e., inlet or outlet).

2. Approximate dimensions of adjacent streams and man-made structures (i.e., average width and average depth of stream, length of bridge, pipe diameter).

IV. Stream Material Sampling

A. Location**

1. Upstream of culvert inlet.

2. Downstream of culvert outlet.

3. Inside Culvert Barrel.

4. Scour hole areas.

B. Quantity and Depth

1. Standard material sample bags should be filled with enough material for performing sieve gradation analysis.

2. Samples should extend to a depth of 12 inches into the existing stream bed.

**Stream bed samples need not be taken at each of these locations if the material does not appear to differ in composition from location to location.

V. Photographs

A. Facing Downstream from the Culvert Outlet

B. Facing Upstream from the Culvert Inlet

C. The Culvert Outlet

D. The Culvert Inlet

E. Special Features (i.e., scour holes, man-made structures, adjacent streams, log barriers within sight distance of the culvert location)

VI. Documentation

A. "Hydraulic Site Evaluation" Form

B. Standard Survey Field Books for Stream Cross-Section Data

APPENDIX B

EVALUATION FORMS

REF. NO. 1-A

FISH PASSAGE EVALUATION FORM

DATE: 10/15/87 DATA BY: Bill Howard, James Bryant

STREAM: Mt. Scott Creek ODF&W REP.: Jay Massey

LOCATION: Approximately 1 + mile off I-205 east on Sunnyside Road, Clackamas County; T2S, R2E, Section 3

TYPE OF INSTALLATION: Concrete Box Culvert

DIMENSIONS: SPAN 10.0' RISE 8.0' DIAM. _____

LENGTH 182'

GRADIENT .01750 foot/foot

SPECIAL FEATURES: Fish baffles on approximately 4 foot spacings.

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Small runs of Coho salmon and winter steelhead. Resident trout population also present.

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X* MODERATE _____ NONCRITICAL _____

   *Critical for salmon and steelhead; important for resident trout.

3. EVALUATION OF INSTALLATION:

   GOOD _____ FAIR _____ POOR X

4. COMMENTS:

Baffle construction not adequate at downstream end of culvert. Water spreads out over apron below lower baffle (fish do not have concentrated flow to jump into). Probably not passable at moderate to low flow.

CORRECTION NEEDED - Add training walls to concentrate flow from lower baffle to edge of the apron. The remainder of the installation looks fine.

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD __X__ FAIR _____ POOR _____

2. CULVERT CAPACITY:

   GOOD __X__ FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING _____ CLOSED __X__

4. CONDITION OF FOUNDATION:

   GOOD __X__ FAIR _____ POOR _____

5. OUTLET SCOUR:

   SEVERE __X__ MODERATE _____ NEGLIGIBLE _____

6. CULVERT STREAM SURFACE

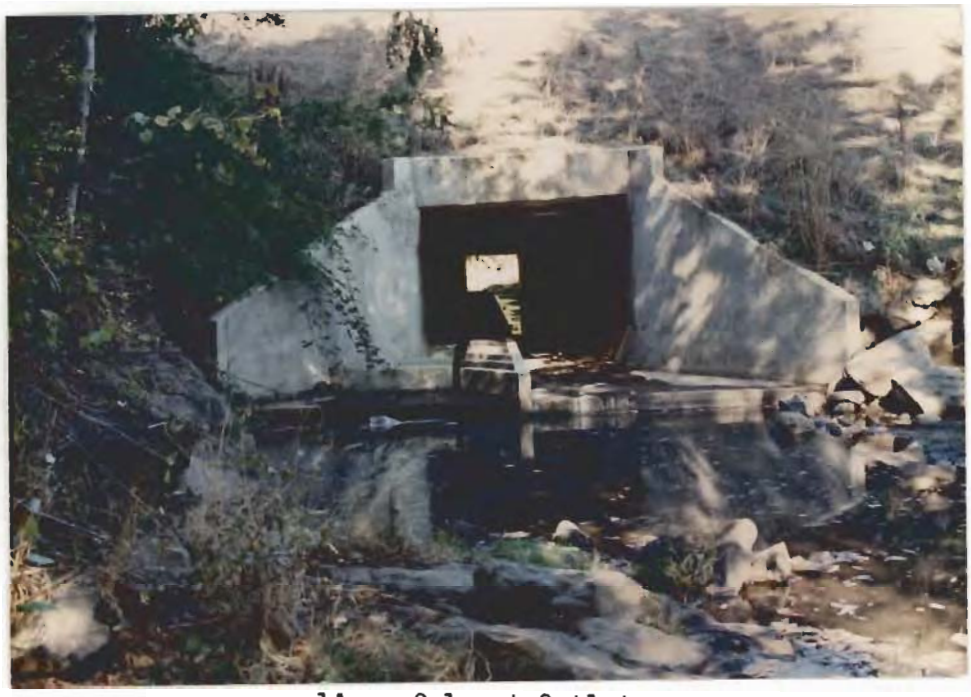
   METAL _____ CONCRETE __X__ NATURAL _____

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS

   COMPATIBLE _____ INCOMPATIBLE __X__

8. COMMENTS: To mitigate the outlet problems, a log barrier system should be installed downstream from the culvert outlet to create a pool extending into the culvert barrel. The pool would reduce outlet velocities and outlet scour depths. The pool would also provide sufficient flow depths for fish desiring passage through the culvert during low flow periods.

REF. NO. 1-A



1Aa - Culvert Outlet

1Ab - Typical Stream Channel

REF. NO. 1-B

FISH PASSAGE EVALUATION FORM

DATE: 10/15/87 DATA BY: Bill Howard, James Bryant

STREAM: Newell Creek ODF&W REP.: Jay Massey

LOCATION: 1.75 miles south of I-205 junction on Hwy. 213, Cascade Hwy., Clackamas County; T2S, R2E, Sections 32 and 33

TYPE OF INSTALLATION: Steel Structural Plate Pipe

DIMENSIONS: SPAN _____ RISE _____ DIAM. 14'

LENGTH 438'

GRADIENT 0.01 foot/foot

SPECIAL FEATURES: Natural stream bed materials and boulders placed throughout the culvert length.

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Small runs of Coho salmon and winter steelhead. Also stream has resident trout population.

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X* MODERATE _____ NONCRITICAL _____

   *Critical for coho and steelhead and important for trout.

3. EVALUATION OF INSTALLATION:

   GOOD X FAIR _____ POOR _____

4. COMMENTS:

Excellent installation for fish passage.

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD X FAIR _____ POOR _____

2. CULVERT CAPACITY:

   GOOD X FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING _____ CLOSED X

4. CONDITION OF FOUNDATION:

   GOOD X FAIR _____ POOR _____

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE X

6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE _____ NATURAL X

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS

   COMPATIBLE X INCOMPATIBLE _____

8. COMMENTS: While the above culvert could possibly be reduced in diameter size without significantly affecting its ability to service the highway and fish passage, overall, the culvert is a good installation for the given design criteria and field conditions.

1Ba - Culvert Outlet

1Bb - Typical Stream Channel

REF. NO. 1-C

FISH PASSAGE EVALUATION FORM

DATE: 10/19/87 DATA BY: Bill Howard, James Bryant

STREAM: Cool Creek ODF&W REP.: Jay Massey

LOCATION: 2-1/2 miles of US 26 on Still Creek Road, Clackamas County; T3S, R7E, Section 24

TYPE OF INSTALLATION: Aluminum Structural Plate Arch

DIMENSIONS: SPAN 14.7' RISE 9.5' DIAM. _____

LENGTH 48'

GRADIENT 0.01 foot/foot

SPECIAL FEATURES: Open bottom arch. Top of footings appear to be 4 feet below stream bed. Man-made pools were built at outlet with log and rock barriers.

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Small runs of Coho salmon and winter steelhead. Resident trout also in stream.
2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X* MODERATE _____ NONCRITICAL _____

   *Critical for salmon and steelhead; important for resident trout.
3. EVALUATION OF INSTALLATION:

   GOOD X FAIR _____ POOR _____
4. COMMENTS: Very good open bottom arch. Man-made pools at outlet may require periodic maintenance.

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD _____ FAIR _____ POOR X

2. CULVERT CAPACITY:

   GOOD _____ FAIR X POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING X CLOSED _____

4. CONDITION OF FOUNDATION:

   GOOD _____ FAIR X POOR _____

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE X

6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE _____ NATURAL X

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE X INCOMPATIBLE _____

8. COMMENTS: Despite the poor installation procedures, the Cool Creek culvert is a good fish passage design.

REF. NO. 1-C

1Ca - Culvert Inlet

1Cb - Typical Stream Channel

REF. NO. 1-D

FISH PASSAGE EVALUATION FORM

DATE: 10/20/87 DATA BY: Bill Howard, James Bryant

STREAM: Lost Creek ODF&W REP.: Jay Massey

LOCATION: Spur Road 109, Clackamas County; T2S, R8E, Section 21

TYPE OF INSTALLATION: Steel Structural Plate Arch

DIMENSIONS: SPAN 18.2' RISE 5.6' DIAM. _____

LENGTH 50'

GRADIENT .014 foot/foot

SPECIAL FEATURES: Open bottom arch. Bottoms of concrete footings are estimated to be only 2 feet below the existing stream bed.

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Fair runs of Coho salmon and winter steelhead. Resident trout also in stream.

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X* MODERATE _____ NONCRITICAL _____

   *Critical for salmon and steelhead; important for resident trout.

3. EVALUATION OF INSTALLATION:

   GOOD X FAIR _____ POOR _____

4. COMMENTS: Excellent open bottom arch arch.

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD _____ FAIR __X__ POOR _____

2. CULVERT CAPACITY:

   GOOD __X__ FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING __X__ CLOSED _____

4. CONDITION OF FOUNDATION:

   GOOD _____ FAIR _____ POOR __X__

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE __X__

6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE _____ NATURAL __X__

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE __X__ INCOMPATIBLE _____

8. COMMENTS: While the above culvert provides good fish passage, a pipe culvert with its metal invert depressed below the natural stream bed would eliminate the possibility of a foundation failure during an extreme flood. Also, log and/or rock barriers could be installed downstream to ensure that the "depressed" culvert did not lose its streambed material.

1Da - Culvert Outlet

1Db - Typical Stream Channel

REF. NO. C-7

FISH PASSAGE
EVALUATION FORM

DATE: 10/20/87 DATA BY: Bill Howard, James Bryant

STREAM: Polallie Creek ODF&W REP.: Jim Newton

LOCATION: 23.2 miles south of Hood River and I-84 junction on US 35, Hood River County; T2S, R10E, Section 5

TYPE OF INSTALLATION: Steel Structural Pipe-Arch

DIMENSIONS: SPAN 12.7' RISE 7.25' DIAM. _____

LENGTH 110'

GRADIENT 0.045 foot/foot

SPECIAL FEATURES: Pipe invert is lined with concrete. Another pipe is located at the site for flood relief. The additional pipe is a 7 foot diameter corrugated steel pipe with no special features for fish passage.

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: May provide some rearing for resident trout and possibly a small number of steelhead.

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL _____ MODERATE _____ NONCRITICAL X

3. EVALUATION OF INSTALLATION:

   GOOD X FAIR _____ POOR _____

4. COMMENTS: Polallie Creek is an unstable, high gradient, high velocity stream with little fish production potential. This stream was devastated by the sudden draining of a glacial impoundment on the slopes of Mt. Hood in 1980. The entire stream was severely scoured by the ensuing flood, which also destroyed portions of Highway 35 and miles of the East Fork of Hood River.

   Polallie Creek has never been considered a significant resident or anadromous fish producer.

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD __X__ FAIR _____ POOR _____

2. CULVERT CAPACITY:

   GOOD _____ FAIR __X__ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING _____ CLOSED __X__

4. CONDITION OF FOUNDATION:

   GOOD __X__ FAIR _____ POOR _____

5. OUTLET SCOUR:

   SEVERE _____ MODERATE __X__ NEGLIGIBLE _____

6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE __X__ NATURAL _____

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE _____ INCOMPATIBLE __X__

8. COMMENTS: In general, the above facility is not considered a good installation for fish passage. If the culvert were to be replaced with fish passage as a design criteria, the culvert installation would probably require oversizing or the placement of baffles and/or natural stream bed materials such as gravels and small boulders to sufficiently reduce stream velocities through the culvert facility.

C7a - Culvert Outlet

C7b - Typical Stream Channel

REF. NO. 14-A

FISH PASSAGE EVALUATION FORM

DATE: 10/22/87 DATA BY: Bill Howard, James Bryant

STREAM: Mottet Creek ODF&W REP.: Duane West

LOCATION: MP 7.6 on FS Road 63, Union County; T4N, R39E, Section 33

TYPE OF INSTALLATION: Corrugated Steel Oval Pipe

DIMENSIONS: SPAN 5.8' RISE 7.0' DIAM. _____

LENGTH 110'

GRADIENT 0.0573 foot/foot

SPECIAL FEATURES: Log weirs and pools are constructed at the outlet of the culvert.

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: There are good numbers of both rainbow trout and summer steelhead in this small tributary stream.

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X MODERATE _____ NONCRITICAL _____

3. EVALUATION OF INSTALLATION:

   GOOD _____ FAIR X POOR _____

4. COMMENTS: This type of facility does an adequate job of passing fish however, it is not as good as the open bottom arch.

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD __X__ FAIR _____ POOR _____

2. CULVERT CAPACITY:

   GOOD _____ FAIR __X__ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING _____ CLOSED __X__

4. CONDITION OF FOUNDATION:

   GOOD __X__ FAIR _____ POOR _____

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE __X__

6. CULVERT STREAM SURFACE:

   METAL __X__ CONCRETE _____ NATURAL _____

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE _____ INCOMPATIBLE __X__

8. COMMENTS: If the culvert were to be replaced in the future, the culvert should be oversized and installed with baffles and/or natural stream bed materials such as gravels and small boulders. This type of facility would significantly reduce culvert velocities and provide flow characteristics similar to the natural stream channel. Thus, a culvert facility that can provide fish passage is possible at this site.

14Aa - Culvert Outlet

14Ab - Typical Stream Channel

REF. NO. 14-B

FISH PASSAGE
EVALUATION FORM

DATE: 10/22/87 DATA BY: Bill Howard, James Bryant

STREAM: Little Looking Glass Creek ODF&W REP.: Duane West

LOCATION: MP 4.5 on FS Road 63, Union County; T3N, R39E, Section 2,

TYPE OF INSTALLATION: Steel Structured Plate Arch

DIMENSIONS: SPAN 17.6' RISE 8.0' DIAM. _____

LENGTH 110'

GRADIENT 0.0164 foot/foot

SPECIAL FEATURES: Open bottom arch. Gabion weirs at outlet.

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Both rainbow trout and summer steelhead inhabit the stream. There are good numbers of both species.

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X MODERATE _____ NONCRITICAL _____

3. EVALUATION OF INSTALLATION:

   GOOD X FAIR _____ POOR _____

4. COMMENTS: Little Looking Glass Creek is an important steelhead spawning and rearing stream. The stream above the culvert contains the best habitat.

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD _____ FAIR __X__ POOR _____

2. CULVERT CAPACITY:

   GOOD __X__ FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING __X__ CONCRETE FOOTING _____ CLOSED _____

4. CONDITION OF FOUNDATION:

   GOOD _____ FAIR _____ POOR __X__

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE __X__

6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE _____ NATURAL __X__

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE _____ INCOMPATIBLE __X__

8. COMMENTS: While the above culvert provides good fish passage, a pipe arch culvert with its metal invert depressed below the natural stream bed would eliminate the possibility of foundation failure during an extreme flood event. Also, log and/or rock barriers could be installed downstream to ensure that the local fishery could traverse the gabions though a series of pools and weirs.

14Ba - Culvert Outlet

14Bb - Typical Stream Channel

REF. NO. 15-A

FISH PASSAGE
EVALUATION FORM

DATE: 10/24/87 DATA BY: Bill Howard, James Bryant

STREAM: Tamarack Gulch ODF&W REP.: Ken Witty

LOCATION: Near Enterprise, Wallowa County; T3N, R47E, Section 34

TYPE OF INSTALLATION: Corrugated Metal Pipe-Arch

DIMENSIONS: SPAN 6.0' RISE 3.9' DIAM. _____

LENGTH 30.7'

GRADIENT 0.0326 foot/foot

SPECIAL FEATURES: None

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Summer steelhead - migratory and resident rainbow trout

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL _____ MODERATE _____ NONCRITICAL X

3. EVALUATION OF INSTALLATION:

   GOOD X FAIR _____ POOR _____

4. COMMENTS: _____

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD __X__ FAIR _____ POOR _____

2. CULVERT CAPACITY:

   GOOD __X__ FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING _____ CLOSED __X__

4. CONDITION OF FOUNDATION:

   GOOD __X__ FAIR _____ POOR _____

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE __X__

6. CULVERT STREAM SURFACE:

   METAL __X__ CONCRETE _____ NATURAL _____

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE _____ INCOMPATIBLE __X__

8. COMMENTS: Although this small, intermittent stream is not critical to the local fishery, a culvert with a rise and span comparable to the existing facility could easily be installed with a depressed invert. The depressed metal invert could be covered with small boulders and natural stream bed materials. This type of facility would significantly reduce culvert velocities and provide flow characteristics similar to the natural stream channel. Thus, a culvert facility that can provide fish passage is possible at this time.

15Aa - Culvert Outlet

15Ab - Typical Stream Channel

REF. NO. 15-B

FISH PASSAGE EVALUATION FORM

DATE: 10/24/89 DATA BY: Bill Howard, James Bryant

STREAM: South Fork Chesnimus Creek ODF&W REP.: Ken Witty

LOCATION: South of junction of FS Roads 4690, 014, and 015 on FS Road 4690, Wallowa County; T3N, R47E, Section 24

TYPE OF INSTALLATION: Corrugated Metal Pipe

DIMENSIONS: SPAN _____ RISE _____ DIAM. 6.7'

LENGTH 36.7'

GRADIENT 0.03 foot/foot

SPECIAL FEATURES: None

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Summer steelhead trout - migratory and resident rainbow trout.
2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL _____ MODERATE X NONCRITICAL _____
3. EVALUATION OF INSTALLATION:

   GOOD _____ FAIR X POOR _____
4. COMMENTS: Creek was dry when inspected on 11/8/88. The downstream end of this culvert could be a barrier at lower stream flows.

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD __X__ FAIR _____ POOR _____

2. CULVERT CAPACITY:

   GOOD __X__ FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING _____ CLOSED __X__

4. CONDITION OF FOUNDATION:

   GOOD __X__ FAIR _____ POOR _____

5. OUTLET SCOUR:

   SEVERE _____ MODERATE __X__ NEGLIGIBLE _____

6. CULVERT STREAM SURFACE:

   METAL __X__ CONCRETE _____ NATURAL _____

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE _____ INCOMPATIBLE __X__

8. COMMENTS: If this culvert is to be replaced, it can be replaced with a culvert barrel area similar to the existing facility provided its invert is depressed below the natural stream bed gradient. The culvert invert should be backfilled with existing stream bed material and small boulders to reduce the barrel velocities. The existing scour hole at the outlet should also be backfilled with similar natural materials to match the stream bed gradient. These measures should provide a facility that blends well with the surrounding stream environment and fishery habitat.

15Ba - Culvert Outlet

15Bb - Typical Stream Channel

REF. NO. D-6

FISH PASSAGE EVALUATION FORM

DATE: 10/24/87 DATA BY: Bill Howard, James Bryant

STREAM: Devil's Run Creek ODF&W REP.: Ken Witty

LOCATION: Wallowa National Forest, Wallowa County; T3N, R47E, Section 3

TYPE OF INSTALLATION: Structural Plate Arch

DIMENSIONS: SPAN 10.2' RISE 4.5' DIAM. _____

LENGTH 44.3'

GRADIENT 0.0135 foot/foot

SPECIAL FEATURES: Open bottom arch. Log trash rack located at culvert inlet.

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Summer steelhead trout - migratory and resident rainbow trout.

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X MODERATE _____ NONCRITICAL _____

3. EVALUATION OF INSTALLATION:

   GOOD X FAIR _____ POOR _____

4. COMMENTS: _____

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD _____ FAIR __X__ POOR _____

2. CULVERT CAPACITY:

   GOOD __X__ FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING __X__ CONCRETE FOOTING _____ CLOSED _____

4. CONDITION OF FOUNDATION:

   GOOD _____ FAIR _____ POOR __X__

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE __X__

6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE _____ NATURAL __X__

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE __X__ INCOMPATIBLE _____

8. COMMENTS: While the above culvert provides good fish passage, a pipe-arch culvert with its invert depressed below the natural stream bed would eliminate the possibility of a foundation failure during an extreme flood event.

D6a - Culvert Outlet

D6b - Typical Stream Channel

REF. NO. C-3

FISH PASSAGE EVALUATION FORM

DATE: 10/25/87 DATA BY: Bill Howard

STREAM: Billy Creek ODF&W REP.: Ken Witty

LOCATION: Wallowa National Forest, Wallowa County; T3N, R47E, Section 7

TYPE OF INSTALLATION: Steel Structural Plate Pipe-Arch

DIMENSIONS: SPAN 6.3' RISE 5.0' DIAM. _____

LENGTH 78.8'

GRADIENT 0.0228 foot/foot

SPECIAL FEATURES: Log weirs and gabions placed at outlet. An additional 48 inch diameter pipe has been installed for flood relief. The additional 48 inch pipe has no special features for fish passage.

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Summer steelhead trout - migratory and resident rainbow trout

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL _____ MODERATE X NONCRITICAL _____

3. EVALUATION OF INSTALLATION:

   GOOD _____ FAIR X POOR X

   Fair at high flows, poor at low flows.

4. COMMENTS: Billy Creek was dry in the vicinity of this culvert when inspected on 11/8/88. This installation and the concerns with it are similar to the situation on Doe Creek (Ref. #C-4). The weirs and gabions below the culvert create barriers during low flows.

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD X FAIR _____ POOR _____

2. CULVERT CAPACITY:

   GOOD X FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING _____ CLOSED X

4. CONDITION OF FOUNDATION:

   GOOD X FAIR _____ POOR _____

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE X

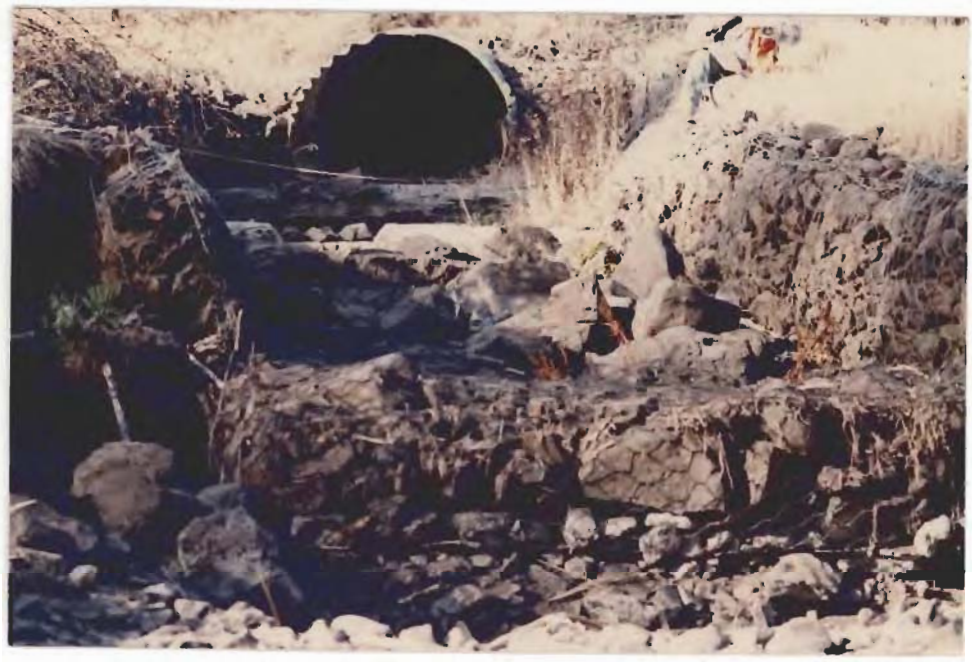
6. CULVERT STREAM SURFACE:

   METAL X CONCRETE _____ NATURAL _____

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE _____ INCOMPATIBLE X

8. COMMENTS: A culvert with a rise and span comparable to the existing facility could be easily installed with a depressed invert. The depressed invert could be covered with small boulders and natural stream bed materials. This type of facility would significantly reduce culvert velocities and provide flow characteristics similar to the natural stream channel. If weirs are maintained at the site, then they should be designed to allow passage of fish during low flow periods by providing flow depths and widths comparable to the natural channel. Also, the water should be prevented from flowing under or through the weirs (i.e., permeable rock gabions).



C3a - Culvert Outlet

C3b - Typical Stream Channel

REF. NO. B-2

FISH PASSAGE
EVALUATION FORM

DATE: 10/26/87 DATA BY: Bill Howard, James Bryant

STREAM: Camp Creek ODF&W REP.: Ken Witty

LOCATION: 1.75 miles from Imnaha on Road 380, Wallowa County, T1N, R48E, Section 20

TYPE OF INSTALLATION: Corrugated Metal Pipe

DIMENSIONS: SPAN _____ RISE _____ DIAM. 8.0'

LENGTH 96.3'

GRADIENT 0.0249 foot/foot

SPECIAL FEATURES: Fish baffles on approximately 15 foot spacings.

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Summer steelhead trout/migratory and resident rainbow trout.

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X MODERATE _____ NONCRITICAL _____

3. EVALUATION OF INSTALLATION:

   GOOD _____ FAIR X POOR _____

4. COMMENTS: There was approximately a 3.5 foot drop at the downstream end of this culvert on 11/8/88. It appears that this installation would block upstream fish passage, but we know that adult steelhead make it up Camp Creek to spawn in the spring. This is one of our index streams for steelhead spawning surveys and we have had good counts above this culvert in recent years.

   There is a deep pool below the outlet of this culvert which probably allows the fish to jump into the culvert. There also would be less drop from this culvert in the spring when flows are higher in Big Sheep Creek.

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD _____ FAIR __X__ POOR _____

2. CULVERT CAPACITY:

   GOOD _____ FAIR _____ POOR __X__

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING _____ CLOSED __X__

4. CONDITION OF FOUNDATION:

   GOOD __X__ FAIR _____ POOR _____

5. OUTLET SCOUR:

   SEVERE __X__ MODERATE _____ NEGLIGIBLE _____

6. CULVERT STREAM SURFACE:

   METAL __X__ CONCRETE _____ NATURAL _____

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE __X__ INCOMPATIBLE _____

8. COMMENTS: A larger culvert should be installed at this site to reduce potential flood damage to the roadway, to reduce barrel velocities prohibitive to fish passage, and to reduce the potential for outlet scour. The replacement culvert should be oversized and set below the existing stream bed elevation to provide a natural stream bed surface with gravels and boulders. The scour hole at the existing outlet should also be filled with gravels and boulders to provide a smooth transition from the Big Sheep Creek channel to the culvert outlet. With this type of in stallation, fish impediment due to high barrel velocities and an excessive vertical drop at the outlet would be significantly reduced to acceptable levels. At this time the backwater from the adjacent Big Sheep Creek possibly reduces the outlet culvert velocities and the vertical outlet drop during high flows. This would explain the passage of fish through the existing installation.

B2a - Culvert Outlet

B2b - Typical Stream Channel

FISH PASSAGE EVALUATION FORM

DATE: 10/23/87 DATA BY: Bill Howard, James Bryant

STREAM: Doe Creek ODF&W REP.: Ken Witty

LOCATION: 35 miles northeast of Enterprise, Wallowa National Forest, Wallowa County; T3N, R46E, Section 14

TYPE OF INSTALLATION: Corrugated Metal Pipe-Arch

DIMENSIONS: SPAN 7.7' RISE 5.4' DIAM. _____

LENGTH 66.6'

GRADIENT 0.0255 foot/foot

SPECIAL FEATURES: Log weirs and gabions placed at outlet

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Summer steelhead trout - migratory and resident rainbow trout.

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL _____ MODERATE X NONCRITICAL _____

3. EVALUATION OF INSTALLATION:

   GOOD _____ FAIR X POOR X

   Fair during high flows, poor during low flows.

4. COMMENTS: Doe Creek was dry when I inspected this culvert on 11/8/88. It appears that this culvert was not set deep enough when the road was constructed and the weirs and gabions below the culvert were installed in an attempt to elevate the stream bed. The weirs are barriers to upstream and downstream passage at low flows. Downstream passage is a concern in these small streams because many of them function as nursery streams. Adult fish enter the streams and spawn soon after flows peak in the spring. The juvenile fish that hatch in these streams will often migrate to higher order streams in late summer or fall, when flows are low, to escape high temperatures or to seek suitable over-winter habitat. It appears that this installation would do a fair job of passing fish during high flows (spawning), but would not pass fish at low flows.

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD X FAIR _____ POOR _____

2. CULVERT CAPACITY:

   GOOD X FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING _____ CLOSED X

4. CONDITION OF FOUNDATION:

   GOOD X FAIR _____ POOR _____

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE X

6. CULVERT STREAM SURFACE:

   METAL X CONCRETE _____ NATURAL _____

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE _____ INCOMPATIBLE X

8. COMMENTS: A culvert with a rise and span comparable to the existing facility could be easily installed with a depressed invert. The depressed invert could be covered with small boulders and natural stream bed materials. This type of facility would significantly reduce culvert velocities and provide flow characteristics similar to the natural stream channel. If weirs are maintained at the site, they should be designed to allow passage of fish during low flow periods by providing flow depths and widths comparable to the natural channel. Also, the water should be prevented from flowing under or through the weirs (i.e., permeable rock gabions.

C4a - Culvert Outlet

C4b - Typical Stream Channel

REF. NO. D-8

FISH PASSAGE EVALUATION FORM

DATE: 10/27/87 DATA BY: Bill Howard, James Bryant

STREAM: Gumboot Creek ODF&W REP.: Ken Witty

LOCATION: Southeast of Joseph on 39 Road, Wallowa County; T4S, R48E, Section 31

TYPE OF INSTALLATION: Structural Plate Arch

DIMENSIONS: SPAN 15.0' RISE 8.5' DIAM. ____

LENGTH 69.0'

GRADIENT 0.0174 foot/foot

SPECIAL FEATURES: Open bottom arch

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Summer steelhead trout - migratory resident rainbow trout, bull trout

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X MODERATE ____ NONCRITICAL ____

3. EVALUATION OF INSTALLATION:

   GOOD X FAIR ____ POOR ____

4. COMMENTS: ____

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD _____ FAIR __X__ POOR _____

2. CULVERT CAPACITY:

   GOOD __X__ FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING __X__ CLOSED _____

4. CONDITION OF FOUNDATION:

   GOOD _____ FAIR _____ POOR __X__

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE __X__

6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE _____ NATURAL __X__

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE __X__ INCOMPATIBLE _____

8. COMMENTS: A pipe-arch with a depressed metal invert could easily be installed at this site without altering the positive fish passage characteristics. While reducing the possibility of structural failure due to scour undermining. The depressed invert should be covered with stream bed materials similar to those located within the existing arch. This measure would ensure depth and velocity characteristics similar to the natural stream channel.

D8a - Culvert Inlet

D8b - Typical Stream Channel

REF. NO. 15-D

FISH PASSAGE EVALUATION FORM

DATE: 11/3/87 DATA BY: Bill Howard, James Bryant

STREAM: Elk Creek ODF&W REP.: Ken Witty

LOCATION: Northeast of Joseph on 46 Road, Wallowa County; T3N, R45E, Section 35

TYPE OF INSTALLATION: Structural Plate Arch

DIMENSIONS: SPAN 13.9' RISE 6.1' DIAM. _____

LENGTH 60'

GRADIENT 0.010 foot/foot

SPECIAL FEATURES: Open bottom arch

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Summer steelhead trout - migratory and resident rainbow trout.

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X MODERATE _____ NONCRITICAL _____

3. EVALUATION OF INSTALLATION:

   GOOD X FAIR _____ POOR _____

4. COMMENTS: _____

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD _____ FAIR __X__ POOR _____

2. CULVERT CAPACITY:

   GOOD __X__ FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING __X__ CLOSED _____

4. CONDITION OF FOUNDATION:

   GOOD _____ FAIR _____ POOR __X__

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE __X__

6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE _____ NATURAL __X__

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE __X__ INCOMPATIBLE _____

8. COMMENTS: A pipe-arch with a depressed metal invert could easily be installed at this site without altering the positive fish passage characteristics while reducing the possibility of structural failure due to scour undermining. The depressed invert should be covered with stream bed materials similar to those located within the existing arch. This measure would ensure the depth and velocity characteristics similar to the natural stream bed.

15Da - Culvert Outlet

15Db - Typical Stream Channel

REF. NO. 15-E

FISH PASSAGE
EVALUATION FORM

DATE: 11/3/87 DATA BY: Bill Howard, James Bryant

STREAM: Chesnimus Creek ODF&W REP.: Ken Witty

LOCATION: Near Enterprise, Wallowa County; T3N, R47E, Section 21

TYPE OF INSTALLATION: Structural Plate Arch

DIMENSIONS: SPAN 11.0' RISE 5.7' DIAM.

LENGTH 49.7'

GRADIENT 0.001 foot/foot

SPECIAL FEATURES: Open bottom arch

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Summer steelhead trout - migratory and resident rainbow trout

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X MODERATE NONCRITICAL

3. EVALUATION OF INSTALLATION:

   GOOD X FAIR POOR

4. COMMENTS: Stream flow was intermittent when I inspected this culvert on 11/8/88.

   This culvert is on Chesnimus Creek at the mouth of Vance Draw.

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD _____ FAIR __X__ POOR _____

2. CULVERT CAPACITY:

   GOOD _____ FAIR __X__ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING __X__ CONCRETE FOOTING _____ CLOSED _____

4. CONDITION OF FOUNDATION:

   GOOD _____ FAIR _____ POOR __X__

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE __X__

6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE _____ NATURAL __X__

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE __X__ INCOMPATIBLE _____

8. COMMENTS: A pipe-arch with a depressed metal invert could easily be installed at this site without altering the positive fish passage characteristics while reducing the possibility of structural failure due to scour undermining. The depressed invert should be covered with stream bed materials similar to those located within the existing arch. This measure would ensure depth and velocity characteristics similar to the natural steam channel.

15Ea - Culvert Inlet

15Eb - Typical Stream Channel

REF. NO. 15-F

FISH PASSAGE EVALUATION FORM

DATE: 11/4/87 DATA BY: Bill Howard, James Bryant

STREAM: Crow Creek ODF&W REP.: Ken Witty

LOCATION: Northeast of Joseph on 46 Road, Wallowa County, T3N, R45E, Section 35

TYPE OF INSTALLATION: Structural Plate Arch

DIMENSIONS: SPAN 12.8' RISE 5.0' DIAM. _____

LENGTH 58.3'

GRADIENT 0.012 foot/foot

SPECIAL FEATURES: Open bottom arch. Another pipe is located at the site for flood relief. The additional pipe is 4 foot diameter, corrugated steel pipe with no special features for fish passage.

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Summer steelhead trout - migratory and resident rainbow trout

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X MODERATE _____ NONCRITICAL _____

3. EVALUATION OF INSTALLATION:

   GOOD X FAIR _____ POOR _____

4. COMMENTS: _____

REF. NO. 15-F

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD X FAIR _____ POOR _____

2. CULVERT CAPACITY:

   GOOD _____ FAIR _____ POOR X

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING X CONCRETE FOOTING _____ CLOSED _____

4. CONDITION OF FOUNDATION:

   GOOD X FAIR _____ POOR _____

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE X

6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE _____ NATURAL X

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE X INCOMPATIBLE _____

8. COMMENTS: In general, this is a good culvert installation. However, if the arch could be replaced, it should be replaced with an installation that would reduce the HW/rise ratio to 1.5 during a 50 year flood event. This would reduce the potential of flood damage to the road due to flood overtopping and debris clogging.

15Fa - Culvert Inlet

15Fb - Typical Stream Channel

REF. NO. 13-A

FISH PASSAGE EVALUATION FORM

DATE: 11/8/87 DATA BY: Bill Howard, James Bryant

STREAM: Meacham Creek ODF&W REP.: Jim Phelps

LOCATION: 0.2 mile north of Meacham on main railroad line just east of old US 30 (MP 239), Umatilla County, T1S, R35E, Section 3

TYPE OF INSTALLATION: Structural Plate Pipe

DIMENSIONS: SPAN 12.8' RISE 14' DIAM. _____

LENGTH 120'

GRADIENT 0.013 foot/foot

SPECIAL FEATURES: Culvert appears to be depressed below the natural stream bed. Another pipe is located at the site for flood relief. The additional pipe is a 10 foot rise by 8.8 foot span, corrugated steel pipe with no special features for fish passage.

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Summer steelhead, resident trout

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL _____ MODERATE X NONCRITICAL _____

3. EVALUATION OF INSTALLATION:

   GOOD _____ FAIR X POOR _____

4. COMMENTS: Adult steelhead spawn upstream from this culvert.

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD __X__ FAIR _____ POOR _____

2. CULVERT CAPACITY:

   GOOD __X__ FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING _____ CLOSED __X__

4. CONDITION OF FOUNDATION:

   GOOD __X__ FAIR _____ POOR _____

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE __X__

6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE _____ NATURAL __X__

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE __X__ INCOMPATIBLE _____

8. COMMENTS: Since the main culvert is depressed 2 to 3 feet below the natural stream bed, small boulders, cobbles, and gravels have been placed within the culvert barrel without significantly restricting the natural stream flow. This installation, thus, provides velocity and depth characteristics similar to the natural stream channel. In general, this is a good installation from the perspective of the highway facility and in terms of fish passage features.

13Aa - Culvert Outlet

13Ab - Typical Stream Channel

REF. NO. 13-B

FISH PASSAGE EVALUATION FORM

DATE: 11/8/87 DATA BY: Bill Howard, James Bryant

STREAM: Meacham Creek ODF&W REP.: Jim Phelps

LOCATION: 1.0 mile north of Meacham on main railroad line just east of old US 30 (MP 239), Umatilla County; T1N, R35E, Section 35

TYPE OF INSTALLATION: Structural Plate Pipe

DIMENSIONS: SPAN _____ RISE _____ DIAM. 15'

LENGTH 143'

GRADIENT 0.013 foot/foot

SPECIAL FEATURES: Culvert appears to be depressed below the natural stream bed. Another pipe is located at the site for flood relief. The additional pipe is a 10 foot diameter, corrugated steel pipe with no special features for fish passage.

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Summer steelhead, resident trout

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL _____ MODERATE X NONCRITICAL _____

3. EVALUATION OF INSTALLATION:

   GOOD _____ FAIR X POOR _____

4. COMMENTS: We are not aware of any passage problems at this location.

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD __X__ FAIR _____ POOR _____

2. CULVERT CAPACITY:

   GOOD __X__ FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING _____ CLOSED __X__

4. CONDITION OF FOUNDATION:

   GOOD __X__ FAIR _____ POOR _____

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE __X__

6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE _____ NATURAL __X__

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE __X__ INCOMPATIBLE _____

8. COMMENTS: Since the main culvert is depressed be 2 to 3 feet below the natural stream bed; small boulders, cobbles, and gravels have been placed within the culvert barrel without significantly restricting the natural stream flow. This installation, thus, provides velocity and depth characteristics similar to the natural stream channel. In general, this is a good installation from the perspective of the highway facility and in terms of fish passage features.

13Ba - Culvert Inlet

13Bb - Typical Channel Section

REF. NO. 13-C

FISH PASSAGE EVALUATION FORM

DATE: 10/8/87 DATA BY: Bill Howard, James Bryant

STREAM: Meacham Creek ODF&W REP.: Jim Phelps

LOCATION: 1.1 miles north of Meacham on main railroad line just east of old US 30 (MP 239), Umatilla County; T1N, R35E, Section 35

TYPE OF INSTALLATION: Structural Plate Pipe-Oval

DIMENSIONS: SPAN 14' RISE 15' DIAM. _____

LENGTH 135'

GRADIENT 0.020 foot/foot

SPECIAL FEATURES: Culvert appears to be depressed below the natural stream bed. Another pipe is located at the site for flood relief. The additional pipe is a 10 foot diameter, corrugated steel pipe with no special features for fish passage.

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Summer steelhead, resident rainbow trout

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL _____ MODERATE X NONCRITICAL _____

3. EVALUATION OF INSTALLATION:

   GOOD _____ FAIR X POOR _____

4. COMMENTS: Not aware of any passage problems.

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD __X__ FAIR _____ POOR _____

2. CULVERT CAPACITY:

   GOOD __X__ FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING _____ CLOSED __X__

4. CONDITION OF FOUNDATION:

   GOOD __X__ FAIR _____ POOR _____

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE __X__

6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE _____ NATURAL __X__

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE __X__ INCOMPATIBLE _____

8. COMMENTS: Since the main culvert is depressed 2 to 3 feet below the natural stream bed; small boulders, cobbles, and gravels have been placed within the culvert barrel without significantly restricting the natural stream flow. This installation, thus, provides velocity and depth characteristics similar to the natural stream channel. In general, this is a good installation from the perspective of the highway facility and in terms of fish passage features.

13Ca - Culvert Barrel

13Cb - Typical Stream Channel

REF. NO. 13-D

FISH PASSAGE EVALUATION FORM

DATE: 11/7/87 DATA BY: Bill Howard, James Bryant

STREAM: Meacham Creek ODF&W REP.: Jim Phelps

LOCATION: 1.4 miles north of Meacham on main railroad line just east of old US 30 (MP 239), Umatilla County, T1N, R35E, Section 35

TYPE OF INSTALLATION: Structural Plate Pipe-Oval

DIMENSIONS: SPAN 20' RISE 20' DIAM. _____

LENGTH 160'

GRADIENT 0.014 foot/foot

SPECIAL FEATURES: Culvert appears to be depressed below the natural stream bed. The culvert is connected to a 25 foot long, single span bridge.

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Summer steelhead, resident rainbow trout

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL _____ MODERATE X NONCRITICAL _____

3. EVALUATION OF INSTALLATION:

   GOOD X FAIR _____ POOR _____

4. COMMENTS: _____

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD __X__ FAIR _____ POOR _____

2. CULVERT CAPACITY:

   GOOD __X__ FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING _____ CLOSED __X__

4. CONDITION OF FOUNDATION:

   GOOD __X__ FAIR _____ POOR _____

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE __X__

6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE _____ NATURAL __X__

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE __X__ INCOMPATIBLE _____

8. COMMENTS: Since the culvert is depressed 3 to 5 feet below the natural stream bed, small boulders cobbles, and gravels have been placed within the culvert barrel without significantly constricting the natural stream flow. This installation, thus, provides velocity and depth characteristics similar to the natural stream channel. In general, this is a good installation from the perspective of the highway facility and in terms of the fish passage features.

13Da - Culvert Barrel

13Db - Typical Stream Channel

REF. NO. 13-E

FISH PASSAGE EVALUATION FORM

DATE: 11/6/87 DATA BY: Bill Howard, James Bryant

STREAM: Sheep Creek ODF&W REP.: Jim Phelps

LOCATION: 1.5 miles north of Meacham on main railroad lone just east of old US 30 (MP 239), Umatilla County, T1N, R35E, Section 35

TYPE OF INSTALLATION: Concrete Underpass and Corrugated Metal Pipe

DIMENSIONS: SPAN _____ RISE _____ DIAM. 7'

LENGTH 124'

GRADIENT 0.053 foot/foot

SPECIAL FEATURES: None. 8.0 foot span by 8.5 foot rise. Concrete underpass connects to a 7 foot diameter corrugated metal pipe.

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Probable summer steelhead, resident rainbow trout

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL _____ MODERATE X NONCRITICAL _____

3. EVALUATION OF INSTALLATION:

   GOOD _____ FAIR _____ POOR X

4. COMMENTS: Gradient between culvert and Meacham Creek is steep and rocky due to railroad construction.

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD __X__ FAIR _____ POOR _____

2. CULVERT CAPACITY:

   GOOD __X__ FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING _____ CLOSED __X__

4. CONDITION OF FOUNDATION:

   GOOD __X__ FAIR _____ POOR _____

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE __X__

6. CULVERT STREAM SURFACE:

   METAL __X__ CONCRETE _____ NATURAL _____

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE _____ INCOMPATIBLE __X__

8. COMMENTS: If passage were required at this site, a culvert with rise a and span comparable to the existing facility could be easily installed with a depressed invert. The depressed invert could be covered with small boulders and natural stream bed materials. This type of facility would significantly reduce culvert velocities and provide flow characteristics similar to the natural stream channel.

13Ea - Culvert Outlet

13Eb - Typical Stream Channel

REF. NO. 12-A

FISH PASSAGE EVALUATION FORM

DATE: 11/12/87 DATA BY: Bill Howard, James Bryant

STREAM: Canyon Creek ODF&W REP.: Errol Claire

LOCATION: Canyon Creek near Wickiup Campground, Grant County; T16S, R32E, Section 2

TYPE OF INSTALLATION: Structural Plate Pipe-Arch

DIMENSIONS: SPAN 12.6' RISE 8.1' DIAM. _____

LENGTH 55'

GRADIENT 0.020 foot/foot

SPECIAL FEATURES: None.

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Rainbow/steelhead/chinook, adults and juveniles

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X MODERATE _____ NONCRITICAL _____

3. EVALUATION OF INSTALLATION:

   GOOD _____ FAIR X POOR _____

4. COMMENTS: Grade too high - pipe not set deep enough - necessitates a rock weir downstream to provide better passage.

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD X FAIR _____ POOR _____

2. CULVERT CAPACITY:

   GOOD _____ FAIR X POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING _____ CLOSED X

4. CONDITION OF FOUNDATION:

   GOOD X FAIR _____ POOR _____

5. OUTLET SCOUR:

   SEVERE X MODERATE _____ NEGLIGIBLE _____

6. CULVERT STREAM SURFACE:

   METAL X CONCRETE _____ NATURAL _____

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE _____ INCOMPATIBLE X

8. COMMENTS: If the culvert were to be replaced in the future, the culvert should be oversized and installed with natural stream bed materials such as gravels and small boulders. This type of facility would significantly reduce culvert velocities and provide flow characteristics similar to the natural stream channel.

12Aa - Culvert Outlet

12Ab - Typical Stream Channel

REF. NO. 12-B

FISH PASSAGE EVALUATION FORM

DATE: 11/12/87 DATA BY: Bill Howard, James Bryant

STREAM: Middle For of Canyon Creek ODF&W REP.: Errol Claire

LOCATION: Middle Fork Canyon Creek, Grant County; T16S, R32E, Section 2

TYPE OF INSTALLATION: Structural Plate Pipe Arch

DIMENSIONS: SPAN 13.5' RISE 8.5 DIAM. _____

LENGTH 90'

GRADIENT 0.022 foot/foot

SPECIAL FEATURES: Culvert appears to be depressed below the natural streambed.

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Rainbow/steelhead/cutthroat, adults and juvenile

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X MODERATE _____ NONCRITICAL _____

3. EVALUATION OF INSTALLATION:

   GOOD X FAIR _____ POOR _____

4. COMMENTS: _____

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD X FAIR _____ POOR _____

2. CULVERT CAPACITY:

   GOOD X FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING _____ CLOSED X

4. CONDITION OF FOUNDATION:

   GOOD X FAIR _____ POOR _____

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE X

6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE _____ NATURAL X

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE X INCOMPATIBLE _____

8. COMMENTS: Since the culvert is depressed 2 to 3 feet below the natural stream bed, small boulders, cobbles, and gravels have been placed within the culvert barrel without significantly restricting the natural stream flow. This installation, thus, provides velocity and depth characteristics similar to the natural stream channel. In general, this is a good installation from the perspective of the highway facility and in terms of fish passage features.

12Ba - Culvert Inlet

12Bb - Typical Stream Channel

REF. NO. 12-C

FISH PASSAGE EVALUATION FORM

DATE: 11/12/87 DATA BY: Bill Howard, James Bryant

STREAM: Canyon Creek ODF&W REP.: Errol Claire

LOCATION: Canyon Creek at junction of US Roads 15 and 1520, Grant County; T16S, R32E, Section 1

TYPE OF INSTALLATION: Structural Plate Pipe

DIMENSIONS: SPAN _____ RISE _____ DIAM. 10'

LENGTH 113'

GRADIENT 0.0177 foot/foot

SPECIAL FEATURES: Culvert appears to be depressed below the natural stream bed.

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Rainbow/steelhead/cutthroat/chinook

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X MODERATE _____ NONCRITICAL _____

3. EVALUATION OF INSTALLATION:

   GOOD X FAIR _____ POOR _____

4. COMMENTS: _____

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD _____ FAIR __X__ POOR _____

2. CULVERT CAPACITY:

   GOOD __X__ FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING _____ CLOSED __X__

4. CONDITION OF FOUNDATION:

   GOOD __X__ FAIR _____ POOR _____

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE __X__

6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE _____ NATURAL __X__

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE __X__ INCOMPATIBLE _____

8. COMMENTS: Since the culvert is depressed approximately 1 foot below the natural stream bed, small boulders, cobbles, and gravels have been periodically placed within the culvert barrel without significantly restricting the natural stream flow. This installation, thus, provides velocity and depth characteristics similar to the natural stream channel. In general, this is a good installation from the perspective of the highway facility and in terms of fish passage characteristics.

REF. NO. 12-C

12Ca - Culvert Barrel

12Cb - Typical Stream Channel

REF. NO. 12-D

FISH PASSAGE EVALUATION FORM

DATE: 11/17/87 DATA BY: Bill Howard, James Bryant

STREAM: Ruby Creek ODF&W REP.: Errol Claire

LOCATION: Middle Fork John Day River Road, Grant County; T11S, R34E, Section 6

TYPE OF INSTALLATION: Corrugated Metal Arch

DIMENSIONS: SPAN 8' RISE 4' DIAM. _____

LENGTH 60'

GRADIENT 0.030 foot/foot

SPECIAL FEATURES: Open bottom arch

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Rainbow/steelhead/chinook, adults and juveniles

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X MODERATE _____ NONCRITICAL _____

3. EVALUATION OF INSTALLATION:

   GOOD X FAIR _____ POOR _____

4. COMMENTS: _____

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD __X__ FAIR _____ POOR _____

2. CULVERT CAPACITY:

   GOOD _____ FAIR __X__ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING __X__ CONCRETE FOOTING _____ CLOSED _____

4. CONDITION OF FOUNDATION:

   GOOD _____ FAIR __X__ POOR _____

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE __X__

6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE _____ NATURAL __X__

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE __X__ INCOMPATIBLE _____

8. COMMENTS: In general, this is a good culvert installation. However, a pipe-arch could have been installed at this site. With a pipe arch, foundation does not have to be set on bedrock or below the scour depth for large flood events.

12Da - Culvert Outlet

12Db - Typical Stream Channel

REF. NO. 12-E

FISH PASSAGE EVALUATION FORM

DATE: 11/17/87 DATA BY: Bill Howard, James Bryant

STREAM: Big Creek ODF&W REP.: Errol Claire

LOCATION: Middle Fork John Day River Road, Grant County; T9S, R31E, Section 21

TYPE OF INSTALLATION: Structural Plate Pipe-Arch

DIMENSIONS: SPAN 12' RISE 7' DIAM. _____

LENGTH 59'

GRADIENT 0.044 foot/foot

SPECIAL FEATURES: Open bottom arch

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Rainbow/steelhead/chinook, adults and juveniles

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X MODERATE _____ NONCRITICAL _____

3. EVALUATION OF INSTALLATION:

   GOOD X FAIR _____ POOR _____

4. COMMENTS: _____

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD _____ FAIR _____ POOR X

2. CULVERT CAPACITY:

   GOOD _____ FAIR X POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING X CONCRETE FOOTING _____ CLOSED _____

4. CONDITION OF FOUNDATION:

   GOOD _____ FAIR _____ POOR X

5. OUTLET SCOUR:

   SEVERE _____ MODERATE X NEGLIGIBLE _____

6. CULVERT STREAM SURFACE:

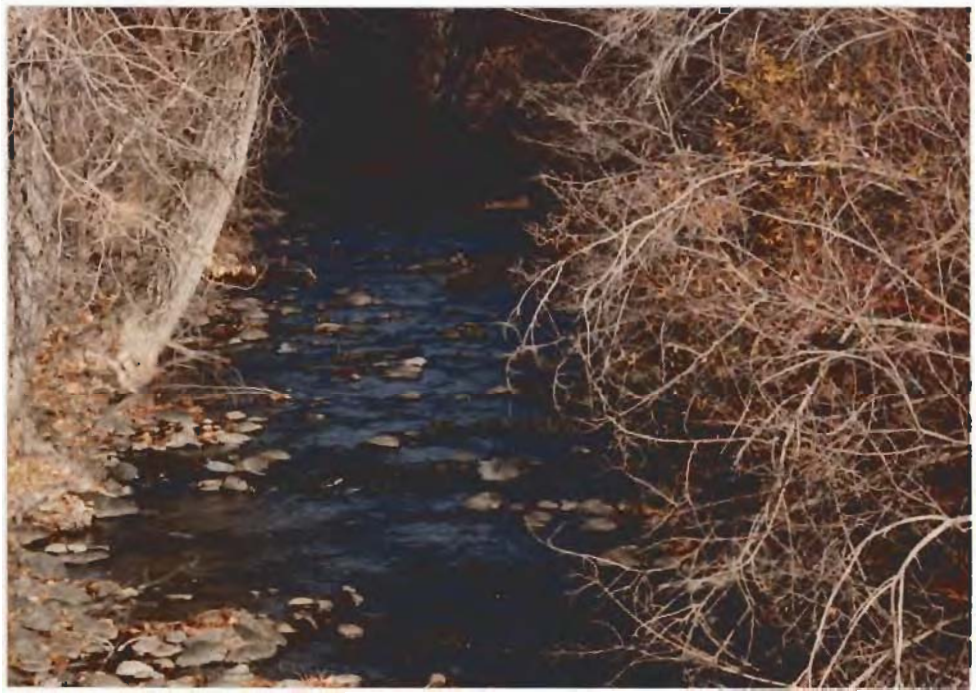
   METAL _____ CONCRETE _____ NATURAL X

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE X INCOMPATIBLE _____

8. COMMENTS: The existing arch should be replaced with an oversized structural plate pipe. The pipe invert could be set below the existing stream gradient and backfilled with natural stream bed material. This alternative would provide the same positive fish passage characteristics as the existing facility while eliminating the possibility of scour failure that currently exists at the site. Also, boulder clusters or log weirs may be required to reduce culvert velocities at the pipe outlet.

12Ea - Culvert Barrel



12Eb - Typical Stream Channel

REF. NO. 12-F

FISH PASSAGE EVALUATION FORM

DATE: 11/18/87 DATA BY: Bill Howard, James Bryant

STREAM: Indian Creek ODF&W REP.: Errol Claire

LOCATION: Middle Fork John Day Road, Grant County; T9S, R32E, Section 7

TYPE OF INSTALLATION: Structural Plate Arch

DIMENSIONS: SPAN 12' RISE 7' DIAM. _____

LENGTH 47'

GRADIENT 0.034 foot/foot

SPECIAL FEATURES: Open bottom arch

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Rainbow/steelhead/chinook, adult and juveniles

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X MODERATE _____ NONCRITICAL _____

3. EVALUATION OF INSTALLATION:

   GOOD X FAIR _____ POOR _____

4. COMMENTS: _____

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD _____ FAIR _____ POOR __X__

2. CULVERT CAPACITY:

   GOOD _____ FAIR __X__ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING __X__ CONCRETE FOOTING _____ CLOSED _____

4. CONDITION OF FOUNDATION:

   GOOD _____ FAIR _____ POOR __X__

5. OUTLET SCOUR:

   SEVERE _____ MODERATE __X__ NEGLIGIBLE _____

6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE _____ NATURAL __X__

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE __X__ INCOMPATIBLE _____

8. COMMENTS: The existing arch should be replaced with an oversized structural plate pipe. The pipe invert should be set below the existing stream bed gradient and backfilled with natural stream bed material. This alternative would provide the same positive fish passage characteristics as the existing facility while eliminating the possibility of scour failure that currently exists at the site. Also, boulder clusters or log weirs may be required to reduce culvert velocities at the pipe outlet.

12Fa - Culvert Outlet

12Fb - Typical Stream Channel

REF. NO. 12-G

FISH PASSAGE EVALUATION FORM

DATE: 11/18/87 DATA BY: Bill Howard, James Bryant

STREAM: Granite Creek ODF&W REP.: Errol Claire

LOCATION: US 395, Grant County; T8S, R31E, Section 17

TYPE OF INSTALLATION: Structural Plate Arch

DIMENSIONS: SPAN 12.8' RISE 5.3' DIAM. _____

LENGTH 74'

GRADIENT 0.012 foot/foot

SPECIAL FEATURES: Open bottom arch

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Rainbow/steelhead/chinook adults and juveniles

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X MODERATE _____ NONCRITICAL _____

3. EVALUATION OF INSTALLATION:

   GOOD X FAIR _____ POOR _____

4. COMMENTS: _____

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD _____ FAIR __X__ POOR _____

2. CULVERT CAPACITY:

   GOOD __X__ FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING __X__ CLOSED _____

4. CONDITION OF FOUNDATION:

   GOOD _____ FAIR _____ POOR __X__

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE __X__

6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE _____ NATURAL __X__

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE __X__ INCOMPATIBLE _____

8. COMMENTS: If the existing arch footings are not set on bedrock, then the arch should be replaced with an oversized structural plate pipe or pipe-arch. The pipe invert should be set below the existing stream bed gradient and backfilled with natural stream bed material. This alternative would provide the same positive fish passage characteristics as the existing facility while eliminating the possibility of scour failure that currently exists at the site.

12Ga - Culvert Barrel

12Gb - Typical Stream Channel

REF. NO. 12-H

FISH PASSAGE EVALUATION FORM

DATE: 11/18/87 DATA BY: Bill Howard, James Bryant

STREAM: Granite Creek ODF&W REP.: Errol Claire

LOCATION: US 395, Grant County; T8S, R31E, Section 17

TYPE OF INSTALLATION: Structural Plate Arch

DIMENSIONS: SPAN 13.1' RISE 6.8 feet" DIAM. _____

LENGTH 72'

GRADIENT 0.015 foot/foot

SPECIAL FEATURES: Open bottom arch

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Rainbow/steelhead/chinook, adults and juveniles

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X MODERATE _____ NONCRITICAL _____

3. EVALUATION OF INSTALLATION:

   GOOD X FAIR _____ POOR _____

4. COMMENTS: _____

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD _____ FAIR __X__ POOR _____

2. CULVERT CAPACITY:

   GOOD __X__ FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING __X__ CLOSED _____

4. CONDITION OF FOUNDATION:

   GOOD _____ FAIR _____ POOR __X__

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE __X__

6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE _____ NATURAL __X__

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE __X__ INCOMPATIBLE _____

8. COMMENTS: The arch should be replaced with an oversized structural plate pipe or pipe-arch. The pipe invert should be set below the existing stream bed gradient and backfilled with natural stream bed material. This alternative would provide the same positive fish passage characteristics as the existing facility while eliminating the possibility of scour failure that currently exists at the site.

12Ha - Culvert Barrel

12Hb - Typical Stream Channel

REF. NO. 12-I

FISH PASSAGE EVALUATION FORM

DATE: 11/19/87 DATA BY: Bill Howard, James Bryant

STREAM: Granite Creek ODF&W REP.: Errol Claire

LOCATION: US 395, Grant County; T8S, R31E, Section 30

TYPE OF INSTALLATION: Structural Plate Arch

DIMENSIONS: SPAN 13.2' RISE 6.9' DIAM. _____

LENGTH 111'

GRADIENT 0.022 foot/foot

SPECIAL FEATURES: Open bottom arch

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Rainbow/steelhead/chinook, adults and juveniles

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X MODERATE _____ NONCRITICAL _____

3. EVALUATION OF INSTALLATION:

   GOOD X FAIR _____ POOR _____

4. COMMENTS: _____

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD _____ FAIR _____ POOR __X__

2. CULVERT CAPACITY:

   GOOD __X__ FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING __X__ CLOSED _____

4. CONDITION OF FOUNDATION:

   GOOD _____ FAIR _____ POOR __X__

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE __X__

6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE _____ NATURAL __X__

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE __X__ INCOMPATIBLE _____

8. COMMENTS: The arch should be replaced with an oversized structural plate pipe or pipe-arch. The pipe invert should be set below the existing stream bed gradient and backfilled with natural stream bed material. This alternative would provide the same positive fish passage characteristics as the existing facility while eliminating the possibility of scour failure that currently exists at the site.

12Ia - Culvert Barrel

12Ib - Typical Stream Channel

REF. NO. 12-J

FISH PASSAGE
EVALUATION FORM

DATE: 11/22/87 DATA BY: Bill Howard, James Bryant

STREAM: Sunflower Creek ODF&W REP.: Errol Claire

LOCATION: 15 miles east of Paulina, Grant County; T16S, R27E, Section 19

TYPE OF INSTALLATION: Structural Plate Pipe-Arch

DIMENSIONS: SPAN 17.3' RISE 10' DIAM. _____

LENGTH 87'

GRADIENT 0.037 foot/foot

SPECIAL FEATURES: Baffles installed on 12 foot spacings

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Wild Rainbow (Redbands), adults and juveniles

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X MODERATE _____ NONCRITICAL _____

3. EVALUATION OF INSTALLATION:

   GOOD X FAIR _____ POOR _____

4. COMMENTS: Must also accommodate steelhead once South Fork Falls is laddered. Presently being reviewed by BPA.

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD __X__ FAIR _____ POOR _____

2. CULVERT CAPACITY:

   GOOD __X__ FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING _____ CLOSED __X__

4. CONDITION OF FOUNDATION:

   GOOD __X__ FAIR _____ POOR _____

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE __X__

6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE _____ NATURAL __X__

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE __X__ INCOMPATIBLE _____

8. COMMENTS: In general, this is a good installation. The baffles aid in the retention of boulder, gravel, and cobble deposits within the barrel. The culvert barrel area is sufficient to pass wooded debris while the baffles do not appear to collect floating debris. Finally, the baffles appear to be the appropriate height for permitting fish passage during low flow periods.

12Ja - Culvert Outlet

12Jb - Typical Stream Channel

REF. NO. 11-A

FISH PASSAGE EVALUATION FORM

DATE: 11/23/87 DATA BY: Bill Howard, James Bryant

STREAM: Marks Creek ODF&W REP.: Ed Schwartz

LOCATION: 25 miles east of Prineville on US 26, Wheeler County; T13S, R19E, Section 17

TYPE OF INSTALLATION: Structural Plate Arch

DIMENSIONS: SPAN 18' RISE 8.8' DIAM. _____

LENGTH 53'

GRADIENT 0.0027 foot/foot

SPECIAL FEATURES: Open bottom arch. Log weirs placed upstream and downstream from culvert.

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Fair population of rainbow trout in some years when steamflows are adequate.
2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL _____ MODERATE X NONCRITICAL _____
3. EVALUATION OF INSTALLATION:

   GOOD X FAIR _____ POOR _____
4. COMMENTS: Conditions under this culvert resemble the natural state very closely.

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD __X__ FAIR _____ POOR _____

2. CULVERT CAPACITY:

   GOOD __X__ FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING __X__ CONCRETE FOOTING _____ CLOSED _____

4. CONDITION OF FOUNDATION:

   GOOD _____ FAIR __X__ POOR _____

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE __X__

6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE _____ NATURAL __X__

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE __X__ INCOMPATIBLE _____

8. COMMENTS: The natural steam bed surface within the culvert barrel provides depth and velocity characteristics similar to the natural stream channel. Thus, the fish passager characteristics are good at this site. Overall, this is a good culvert installation.

11Aa - Culvert Outlet

11Ab - Typical Stream Channel

REF. NO. 10-A

FISH PASSAGE EVALUATION FORM

DATE: 11/23/87 DATA BY: Bill Howard, James Bryant

STREAM: Brown's Creek ODF&W REP.: Ted Fies

LOCATION: Tributary to Wickiup Reservoir, Deschutes County; T21S, R8E, Section 29

TYPE OF INSTALLATION: Structural Plate Pipe-Arch

DIMENSIONS: SPAN 12.6' RISE 9.4' DIAM. _____

LENGTH 76'

GRADIENT 0.005 foot/foot

SPECIAL FEATURES: Culvert appears to be depressed below the natural stream bed.

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Spawning brown trout, spawnin kokanee

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X MODERATE _____ NONCRITICAL _____

3. EVALUATION OF INSTALLATION:

   GOOD X FAIR _____ POOR _____

4. COMMENTS: The Brown's Creek arch culvert has worked extremely well. It poses absolutely no problems for adult fish or juvenile fish moving up or downstream.

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD X FAIR _____ POOR _____

2. CULVERT CAPACITY:

   GOOD X FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING _____ CLOSED X

4. CONDITION OF FOUNDATION:

   GOOD X FAIR _____ POOR _____

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE X

6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE _____ NATURAL X

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE X INCOMPATIBLE _____

8. COMMENTS: Although some of the pipe invert metal is exposed, the flat gradient and the sporadic deposition of natural stream bed materials within the culvert barrel provide depth and velocity characteristics similar to the natural stream channel. Thus, the fish passage characteristics are good at this site. Overall, this is a good culvert installation.

10Aa - Culvert Inlet

10Ab - Typical Stream Channel

REF. NO. 2-A

FISH PASSAGE EVALUATION FORM

DATE: 11/27/87 DATA BY: Bill Howard, James Bryant

STREAM: Lowe Creek ODF&W REP.: Jay Massey

LOCATION: FS Road 4671, Clackamas County; T7S, R73, Section 24

TYPE OF INSTALLATION: Structural Plate Arch

DIMENSIONS: SPAN 21.7' RISE 11.7' DIAM. _____

LENGTH 72'

GRADIENT 0.05 foot/foot

SPECIAL FEATURES: Open bottom arch with boulders placed inside the barrel.

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Small runs of Coho salmon and winter steelhead. Also, resident trout in the system.

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X* MODERATE _____ NONCRITICAL _____

   *Critical for salmon and steelhead; important for resident trout.

3. EVALUATION OF INSTALLATION:

   GOOD X FAIR _____ POOR _____

4. COMMENTS: Excellent open bottom arch installation.

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD _____ FAIR __X__ POOR _____

2. CULVERT CAPACITY:

   GOOD __X__ FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING __X__ CLOSED _____

4. CONDITION OF FOUNDATION:

   GOOD _____ FAIR _____ POOR __X__

5. OUTLET SCOUR:

   SEVERE _____ MODERATE __X__ NEGLIGIBLE _____

6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE _____ NATURAL __X__

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE __X__ INCOMPATIBLE _____

8. COMMENTS: In general, the above culvert is a good highway and fish passage installation. However, open bottom arches with shallow foundations are susceptible to scour if not placed on nonerodible materials (i.e., bedrock). If this foundation requirement cannot be met, then a pipe culvert with its metal invert depressed below the natural stream bed gradient should be installed at these types of locations.

2Aa - Culvert Inlet

2Ab - Typical Stream Channel

REF. NO. 2-B

FISH PASSAGE EVALUATION FORM

DATE: 11/28/87 DATA BY: Bill Howard, James Bryant

STREAM: Poop Creek ODF&W REP.: Jay Massey

LOCATION: On FS Road 42, east of Camp Creek Road, Clackamas County; T7S, R8E, Section 9

TYPE OF INSTALLATION: Corrugated Metal Pipe

DIMENSIONS: SPAN _____ RISE _____ DIAM. 4'

LENGTH 50'

GRADIENT 0.059 foot/foot

SPECIAL FEATURES: Man-made pools were built at inlet and outlet with log barriers.

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: We don't have good inventory information on Poop Creek. May have a few Coho salmon and winter steelhead in the stream. Resident trout are in the system.

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X* MODERATE _____ NONCRITICAL _____

   Critical for salmon and steelhead; important for resident trout.

3. EVALUATION OF INSTALLATION:

   GOOD _____ FAIR X POOR _____

4. COMMENTS: Passage okay. Gradient a little steep for good fish passage.

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD __X__ FAIR _____ POOR _____

2. CULVERT CAPACITY:

   GOOD __X__ FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING _____ CLOSED __X__

4. CONDITION OF FOUNDATION:

   GOOD __X__ FAIR _____ POOR _____

5. OUTLET SCOUR:

   SEVERE _____ MODERATE __X__ NEGLIGIBLE _____

6. CULVERT STREAM SURFACE:

   METAL __X__ CONCRETE _____ NATURAL _____

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE _____ INCOMPATIBLE __X__

8. COMMENTS: The pipe metal invert and the steep pipe slope (i.e., 0.059 foot/foot) induce stream velocities through the culvert facility that are 2 to 3 times greater than the stream velocities encountered in the natural channel cross section. Also scour was observed at the pipe outlet due to these high velocities. Thus, the pipe culvert may inhibit passage of fisheries during high runoff periods. If the culvert were to be replaced in the future, the culvert would require oversizing for the placement of baffles and/or natural stream bed materials such as gravels and small boulders to sufficiently reduce stream velocities at the culvert facility. Furthermore, the short culvert length of 50 feet may permit passage of fish under flow conditions that otherwise would not occur in a longer culvert length. Thus, if the pipe culvert is lengthened during the replacement process, the stream velocities within the culvert barrel may require further reduction to compensate for the additional length the fishery must traverse at the culvert site.

2Ba - Culvert Inlet

2Bb - Typical Stream Channel

REF. NO. 3-A

FISH PASSAGE
EVALUATION FORM

DATE: 12/1/87 DATA BY: Bill Howard, James Bryant

STREAM: Pine Creek ODF&W REP.: John Haxton

LOCATION: 18 miles south of Molalla, Clackamas County; T6S, R3E, Section 27

TYPE OF INSTALLATION: Corrugated Metal Pipe

DIMENSIONS: SPAN _____ RISE _____ DIAM. 7.5'

LENGTH 46'

GRADIENT 0.026 foot/foot

SPECIAL FEATURES: An additional 36 inch diameter pipe has been installed for flood relief. The flood relief pipe does not have any special features for fish passage.

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Resident cutthroat trout

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL _____ MODERATE _____ NONCRITICAL X

3. EVALUATION OF INSTALLATION:

   GOOD X FAIR _____ POOR _____

4. COMMENTS: Pine Creek was surveyed this year. This structure was surveyed August 4th. No log weirs were observed.

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD _____ FAIR __X__ POOR _____

2. CULVERT CAPACITY:

   GOOD _____ FAIR __X__ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING _____ CLOSED __X__

4. CONDITION OF FOUNDATION:

   GOOD __X__ FAIR _____ POOR _____

5. OUTLET SCOUR:

   SEVERE __X__ MODERATE _____ NEGLIGIBLE _____

6. CULVERT STREAM SURFACE:

   METAL __X__ CONCRETE _____ NATURAL _____

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE _____ INCOMPATIBLE __X__

8. COMMENTS: The metal invert and steep gradient create barrel velocities that are nearly double the velocities in the natural stream channel. Also, a 2 to 3 foot deep scour hole that may impede fish passage at lower flows. However, the short pipe length and a natural beaver pond below the pipe may permit the passage of fish through the installation.

   In general, this is not a good installation for the passage of fish. If the pipe were replaced and/or lengthened, fish passage would be difficult under the current circumstances. Also, there is no guarantee that the beaver pond will remain in place.

3Aa - Culvert Outlet

3Ab - Typical Stream Channel

REF. NO. 7-A

FISH PASSAGE
EVALUATION FORM

DATE: 12/8/87 DATA BY: Bill Howard, James Bryant

STREAM: Haight Creek ODF&W REP.: Jerry MacLeod

LOCATION: Upper Siuslaw River Tributary, Lane County; T19S, R7W, Section 34

TYPE OF INSTALLATION: Structural Plate Arch

DIMENSIONS: SPAN 18.2' RISE 8.9' DIAM. _____

LENGTH 69'

GRADIENT 0.0015 foot/foot

SPECIAL FEATURES: Open bottom arch

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Anadromous and resident salmonids. Including chinook and coho salmon and cutthroat and steelhead trout. Would not affect condition of species.

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X MODERATE _____ NONCRITICAL _____

3. EVALUATION OF INSTALLATION:

   GOOD X FAIR _____ POOR _____

4. COMMENTS: Access to stream good at most flows, except extreme low summer time. Metal of culvert beginning to corrode near waterline, but concrete sill shows no sign of wear. No buildup of gravel or other material. Soft sandstone bedrock bottom. Bridge was offset from normal stream channel by 15 feet on upstream end. Bridge should have been placed more directly in-line with stream flow. Some erosion noted at this point, probably due to creation of back eddy.

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD _____ FAIR __X__ POOR _____

2. CULVERT CAPACITY:

   GOOD __X__ FAIR _____ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING __X__ CLOSED _____

4. CONDITION OF FOUNDATION:

   GOOD _____ FAIR __X__ POOR _____

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE __X__

6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE _____ NATURAL __X__

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE __X__ INCOMPATIBLE _____

8. COMMENTS: This open bottom arch is a good installation overall. However, the concrete footings appear to be located on sandstone. Thus, scour at the foundations may be a problem.

REF. NO. 7-A

7Aa - Culvert Barrel

7Ab - Typical Stream Channel

REF. NO. 7-B

FISH PASSAGE EVALUATION FORM

DATE: 12/8/87 DATA BY: Bill Howard, James Bryant

STREAM: Eames Creek ODF&W REP.: Jerry MacLeod

LOCATION: Wolf Creek Tributary, Lane County; T19S, R6W, Section 7

TYPE OF INSTALLATION: Structural Plate Arch

DIMENSIONS: SPAN 13.8' RISE 6.9' DIAM. _____

LENGTH 56'

GRADIENT 0.002 foot/foot

SPECIAL FEATURES: Open bottom arch

EVALUATION OF PASSAGE FACILITIES BY ODF&W PERSONNEL:

1. TYPE AND CONDITION OF SPECIES: Anadromous and resident salmonids. Including chinook and coho salmon and cutthroat and steelhead trout. Would not affect condition of species.

2. IMPORTANCE OF INSTALLATION TO SUBJECT SPECIES:

   CRITICAL X MODERATE _____ NONCRITICAL _____

3. EVALUATION OF INSTALLATION:

   GOOD X FAIR _____ POOR _____

4. COMMENTS: Access to stream good at most flows, even extremely low flows. No build-up of gravel or other material. Soft sandstone bedrock bottom.

   Bridge not constructed directly in-line with stream, but off 20 to 30 degrees to left as you look downstream. Rip-rap material prevents any damage to stream banks.

EVALUATION OF CULVERT INSTALLATION BY WFLHD PERSONNEL:

1. CULVERT CONDITION:

   GOOD _____ FAIR __X__ POOR _____

2. CULVERT CAPACITY:

   GOOD _____ FAIR __X__ POOR _____

3. TYPE OF CULVERT FOUNDATION:

   METAL FOOTING _____ CONCRETE FOOTING __X__ CLOSED _____

4. CONDITION OF FOUNDATION:

   GOOD _____ FAIR __X__ POOR _____

5. OUTLET SCOUR:

   SEVERE _____ MODERATE _____ NEGLIGIBLE __X__

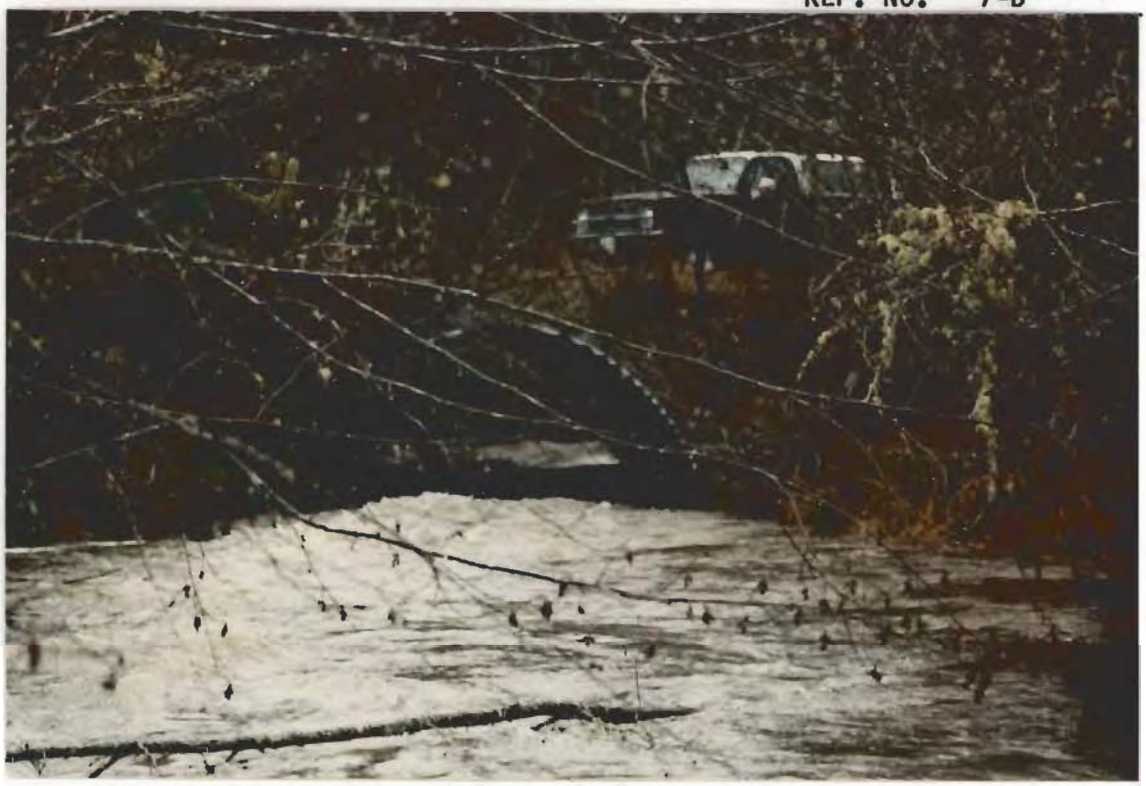
6. CULVERT STREAM SURFACE:

   METAL _____ CONCRETE _____ NATURAL __X__

7. CULVERT HYDRAULICS V. NATURAL STREAM HYDRAULICS:

   COMPATIBLE __X__ INCOMPATIBLE _____

8. COMMENTS: This open bottom arch is a good installation overall. However, the concrete footings appear to be located on sandstone. Thus, scour at the foundations may be a problem.



7Ba - Culvert Outlet

7Bb - Typical Stream Channel

APPENDIX C

STREAM HYDROLOGY

LIST OF SYMBOLS AND DIMENSIONS

Q2	Two year flood, in cubic feet per second (cfs)
Q5	Five year flood, in cubic feet per second (cfs)
Q10	Ten year flood, in cubic feet per second (cfs)
Q25	Twenty-five year flood, in cubic feet per second (cfs)
Q50	Fifty year flood, in cubic feet per second (cfs)
Q100	One hundred year flood, in cubic feet per second (cfs)
P	Mean annual precipitation, in inches
F	Percent of basin forest
I	Precipitation intensity, in inches
ST	Area of lakes and ponds, in percent
TI	Mean basin January minimum temperature, in degrees
L	Length of channel, in miles

SUMMARY OF HYDROLOGIC COMPUTATIONS

EASTERN OREGON

NORTHEAST REGION 2

LOCATION	LAT.	LONG.	A SQ. MI.	P INCHES	F PERCENT	Q2 CFS	Q5 CFS	Q10 CFS	Q25 CFS	Q50 CFS	Q100 CFS
SUNFLOWER	44-10.0	119-35.0	22.60	20.00	50.00	133	231	303	395	486	565
GRANITE	44-53.0	119-01.0	11.40	20.00	50.00	76	134	178	233	289	336
GRANITE	44-51.5	119-02.0	14.50	20.00	50.00	93	162	214	281	347	403
RUBY	44-38.0	118-40.0	5.50	20.00	50.00	42	76	101	133	166	193
INDIAN	44-47.5	118-55.0	23.50	25.00	50.00	186	303	387	490	592	677
BIG	44-46.0	118-52.5	30.70	25.00	50.00	232	375	477	602	725	830
CANYON	44-13.5	118-51.0	27.80	25.00	50.00	214	346	441	558	673	770
MF. CAN	44-13.3	118-50.5	11.90	25.00	50.00	107	177	228	290	353	404
CANYON	44-13.0	118-50.0	11.50	25.00	50.00	104	173	222	283	344	394
MOTTET	45-47.0	117-56.0	10.80	30.00	50.00	126	200	251	313	376	425
L. LOOKING	45-47.0	117-53.0	18.20	30.00	50.00	194	302	378	468	559	631
TAMARACK	45-42.0	116-55.5	2.00	15.00	70.00	11	22	31	43	55	65
S.F. CHESNIMUS	45-44.0	116-54.5	4.80	15.00	70.00	23	45	62	84	107	126
CAMP	45-33.0	116-50.5	48.20	15.00	70.00	153	278	373	497	619	729
CHESNIMUS	45-40.0	116-57.0	25.50	15.00	70.00	91	168	227	304	381	449
CROW	45-42.5	117-09.5	55.80	12.50	70.00	135	256	351	478	603	719
GUMBOOT	45-11.0	116-52.5	18.80	25.00	70.00	142	230	292	368	444	504
DEVIL'S RUN	45-46.5	116-55.5	6.10	15.00	70.00	28	54	74	101	129	151
BILLY	45-46.0	116-59.5	10.70	15.00	70.00	45	85	115	156	197	232
DOE	45-45.0	117-01.0	5.30	15.00	70.00	25	49	67	91	116	136
ELK	45-42.5	117-09.5	25.50	12.50	70.00	71	138	191	261	333	397

SUMMARY OF HYDROLOGIC COMPUTATIONS

NORTH CENTRAL REGION 3

LOCATION	LAT.	LONG.	A SQ. MI.	P INCHES	TI DEGREES	Q2 CFS	Q5 CFS	Q10 CFS	Q25 CFS	Q50 CFS	Q100 CFS
MARK	44-27.0	120-27.5	29.10	25.00	16.00	116	241	330	481	595	757
MEACHAM	44-30.5	118-25.0	16.20	20.00	18.00	74	172	250	387	499	655
MEACHAM	44-30.6	118-24.5	22.20	20.00	18.00	96	219	316	486	622	814
MEACHAM	44-30.6	118-24.4	22.30	20.00	18.00	96	220	317	487	624	816
MEACHAM	44-30.6	118-24.0	22.40	20.00	18.00	96	221	318	489	626	819
SHEEP	44-30.6	118-23.9	3.00	20.00	18.00	19	48	72	115	153	204
POLALLIE	45-25.0	121-34.0	4.33	90.00	26.00	423	647	772	952	1088	1276

EASTERN CASCADES REGION 4

LOCATION	LAT.	LONG.	P INCHES	L MILES	Q2 CFS	Q5 CFS	Q10 CFS	Q25 CFS	Q50 CFS	Q100 CFS
BROWN	43-43.0	121-48.0	25.00	13.00	98	180	249	333	412	500

WESTERN OREGON
COAST REGION 1

LOCATION	LAT.	LONG.	A SQ. MI.	I INCHES	ST PERCENT	Q2 CFS	Q5 CFS	Q10 CFS	Q25 CFS	Q50 CFS	Q100 CFS
HAIGHT	43-52.5	123-30.0	4.00	3.50	0.00	190	269	318	382	438	481
EAMES	43-57.5	123-27.0	5.20	3.75	0.00	279	395	466	560	642	704

SUMMARY OF HYDROLOGIC COMPUTATIONS

WILLAMETTE REGION 2

LOCATION	LAT.	LONG.	A SQ. MI.	I INCHES	Q2 CFS	Q5 CFS	Q10 CFS	Q25 CFS	Q50 CFS	Q100 CFS
PINE	45-01.0	122-25.0	4.00	3.50	248	368	454	571	664	760
LOWE	44-57.5	121-52.5	6.80	3.75	442	654	800	1001	1160	1322
POOP	44-57.5	121-50.5	1.74	3.75	135	197	241	302	350	398
MT. SCOTT	45-26.0	122-32.5	2.65	2.70	111	171	216	279	329	383
COOL	45-17.5	121-53.0	1.65	4.00	144	208	253	315	363	412
LOST	45-22.5	121-50.0	3.20	4.00	256	372	453	563	650	738
NEWELL	45-21.0	122-35.0	2.10	2.75	94	144	181	233	275	319

APPENDIX D

STREAM CHANNEL HYDRAULICS

NATURAL STREAM CHANNEL HYDRAULICS

STREAM NAME	(T) RETURN INTERVAL YEARS	(Q) RUNOFF Q CFS	(B) BOTTOM WIDTH FEET	(ZF) FORE SLOPE HOR UNIT	(ZB) BACK SLOPE HOR UNIT	(N) MANNINGS ROUGHNESS N	(S) DITCH SLOPE FT/FT	(D) FLOW DEPTH FEET	(V) VELOCITY FPS	(TD) SHEAR STRESS LB/FT2	(RS) RIPRAP SIZE D50,FT
MT SCOTT	2	110.00	10.00	2.50	2.00	0.045	0.0175	1.70	4.68	1.86	0.37
MT SCOTT	50	329.99	10.00	2.50	2.00	0.045	0.0175	3.00	6.57	3.28	0.66
NEWELL	2	96.73	13.00	3.50	1.50	0.045	0.0100	1.60	3.56	1.00	0.20
NEWELL	50	278.10	13.00	3.50	1.50	0.045	0.0100	2.80	4.97	1.75	0.35
COOL	2	145.63	6.00	4.00	2.00	0.045	0.0100	2.50	4.31	1.56	0.31
COOL	50	364.07	6.00	4.00	2.00	0.045	0.0100	3.80	5.51	2.37	0.47
LOST	2	258.04	18.00	1.00	4.00	0.045	0.0140	2.10	5.28	1.83	0.37
LOST	50	651.24	18.00	1.00	4.00	0.045	0.0140	3.50	6.96	3.06	0.61
POLLALIE	2	424.59		4.00	4.50	0.045	0.0430	3.30	9.17	8.85	1.77
POLLALIE	50	1090.91		4.00	4.50	0.045	0.0430	4.70	11.62	12.61	2.52
MOTTET	2	125.52	3.00	8.00	3.00	0.045	0.0500	1.60	6.65	4.99	1.00
MOTTET	50	375.00	3.00	8.00	3.00	0.045	0.0500	2.50	8.96	7.80	1.56
LOOKING GLASS	2	193.70		6.67	46.67	0.045	0.0224	1.40	3.71	1.96	0.39
LOOKING GLASS	50	557.85		6.67	46.67	0.045	0.0224	2.10	4.74	2.94	0.59
TAMARACK GULCH	2	11.00		5.00	7.00	0.040	0.0326	0.80	2.87	1.63	0.33
TAMARACK GULCH	50	55.01		5.00	7.00	0.040	0.0326	1.40	4.68	2.85	0.57
S.F. CHESNIMUS	2	23.24	7.00	9.00	3.50	0.040	0.0300	0.60	3.60	1.12	0.22
S.F. CHESNIMUS	50	103.82	7.00	9.00	3.50	0.040	0.0300	1.30	5.28	2.43	0.49
DEVILS RUN	2	27.89	5.00	5.00	5.00	0.040	0.0160	0.90	3.26	0.90	0.18
DEVILS RUN	50	128.62	5.00	5.00	5.00	0.040	0.0160	1.90	4.67	1.90	0.38
BILLY CREEK	2	44.94	6.00	1.00	1.50	0.040	0.0200	1.30	4.53	1.62	0.32
BILLY CREEK	50	125.52	6.00	1.00	1.50	0.040	0.0200	2.20	6.52	2.75	0.55
CAMP CREEK	2	153.41	10.00	3.50	1.75	0.040	0.0267	1.60	6.75	2.67	0.53
CAMP CREEK	50	619.83	10.00	3.50	1.75	0.040	0.0267	3.30	10.06	5.50	1.10
DOE CREEK	2	24.79	8.00	2.00	1.00	0.040	0.0250	0.70	3.91	1.09	0.22
DOE CREEK	50	116.22	8.00	2.00	1.00	0.040	0.0250	1.70	6.48	2.65	0.53

NATURAL STREAM CHANNEL HYDRAULICS

STREAM NAME	(T) RETURN INTERVAL YEARS	(Q) RUNOFF Q CFS	(B) BOTTOM WIDTH FEET	(ZF) FORE SLOPE HOR UNIT	(ZB) BACK SLOPE HOR UNIT	(N) MANNINGS ROUGHNESS N	(S) DITCH SLOPE FT/FT	(D) FLOW DEPTH FEET	(V) VELOCITY FPS	(TD) SHEAR STRESS LB/FT2	(RS) RIPRAP SIZE D50,FT
GUMBOOT CREEK	2	141.79	5.00	15.00	7.00	0.045	0.0230	1.50	4.40	2.15	0.43
GUMBOOT CREEK	50	441.63	5.00	15.00	7.00	0.045	0.0230	2.40	5.86	3.44	0.69
ELK CREEK	2	71.28	15.00	0.75	10.00	0.045	0.0190	1.00	3.50	1.19	0.24
ELK CREEK	50	333.16	15.00	0.75	10.00	0.045	0.0190	2.20	5.65	2.61	0.52
CHESNIMUS CREEK	2	91.43	8.00	5.00	7.50	0.040	0.0100	1.50	3.51	0.94	0.19
CHESNIMUS CREEK	50	381.20	8.00	5.00	7.50	0.040	0.0100	2.90	5.03	1.81	0.36
CROW CREEK	2	134.81		2.50	3.50	0.040	0.0130	3.00	4.99	2.43	0.49
CROW CREEK	50	602.79		2.50	3.50	0.040	0.0130	5.20	7.43	4.22	0.84
MEACHAM NO. 1 CRK	2	74.38	10.00	1.50	1.50	0.045	0.0100	1.60	3.75	1.00	0.20
MEACHAM NO. 1 CRK	50	500.52	10.00	1.50	1.50	0.045	0.0100	4.50	6.64	2.81	0.56
MEACHAM NO. 6 CRK	2	94.52	9.00	3.25	2.50	0.045	0.0150	1.60	4.34	1.50	0.30
MEACHAM NO. 6 CRK	50	624.48	9.00	3.25	2.50	0.045	0.0150	4.10	7.33	3.84	0.77
MEACHAM NO. 7 CRK	2	94.52	10.00	2.50	2.00	0.045	0.0240	1.40	5.13	2.10	0.42
MEACHAM NO. 7 CRK	50	624.48	10.00	2.50	2.00	0.045	0.0240	3.80	8.86	5.69	1.14
MEACHAM NO. 9 CRK	2	94.52	10.00	2.50	1.50	0.045	0.0180	1.50	4.85	1.68	0.34
MEACHAM NO. 9 CRK	50	624.48	10.00	2.50	1.50	0.045	0.0180	4.10	8.37	4.61	0.92
SHEEP CREEK	2	20.14	6.00	0.33	0.67	0.050	0.0600	0.70	4.53	2.62	0.52
SHEEP CREEK	50	150.31	6.00	0.33	0.67	0.050	0.0600	2.30	9.14	8.61	1.72
CANYON CREEK NO. 1	2	215.39	7.00	2.00	1.50	0.045	0.0210	2.70	6.80	3.54	0.71
CANYON CREEK NO. 1	50	674.85	7.00	2.00	1.50	0.045	0.0210	4.80	9.13	6.29	1.26
MF CANYON CREEK	2	110.02	10.00	5.50	5.50	0.045	0.0200	1.40	4.44	1.75	0.35
MF CANYON CREEK	50	350.21	10.00	5.50	5.50	0.045	0.0200	2.50	5.90	3.12	0.62
CANYON CREEK NO. 3	2	105.37	6.00	1.75	1.50	0.040	0.0180	2.00	5.70	2.25	0.45
CANYON CREEK NO. 3	50	344.78	6.00	1.75	1.50	0.040	0.0180	3.60	8.08	4.04	0.81
RUBY CREEK	2	40.29	7.00	2.25	1.50	0.040	0.0260	1.00	4.54	1.62	0.32
RUBY CREEK	50	165.03	7.00	2.25	1.50	0.040	0.0260	2.10	7.19	3.41	0.68

NATURAL STREAM CHANNEL HYDRAULICS

STREAM NAME	(T) RETURN INTERVAL YEARS	(Q) RUNOFF Q CFS	(B) BOTTOM WIDTH FEET	(ZF) FORE SLOPE HOR UNIT	(ZB) BACK SLOPE HOR UNIT	(N) MANNINGS ROUGHNESS N	(S) DITCH SLOPE FT/FT	(D) FLOW DEPTH FEET	(V) VELOCITY FPS	(TD) SHEAR STRESS LB/FT2	(RS) RIPRAP SIZE D50,FT
BIG CREEK	2	230.11	13.00	2.00	0.75	0.040	0.0330	1.80	8.26	3.71	0.74
BIG CREEK	50	725.21	13.00	2.00	0.75	0.040	0.0330	3.40	12.07	7.00	1.40
INDIAN CREEK	2	185.18	9.00	4.50	3.00	0.040	0.0400	1.60	7.72	3.99	0.80
INDIAN CREEK	50	590.39	9.00	4.50	3.00	0.040	0.0400	2.80	10.81	6.99	1.40
GRANITE CRK NO. 1	2	75.15	7.00	5.00	5.00	0.040	0.0230	1.20	4.82	1.72	0.34
GRANITE CRK NO. 1	50	289.77	7.00	5.00	5.00	0.040	0.0230	2.30	6.81	3.30	0.66
GRANITE CRK NO. 2	2	75.15	8.00	4.00	8.00	0.045	0.0250	1.20	4.12	1.87	0.37
GRANITE CRK NO. 2	50	289.77	8.00	4.00	8.00	0.045	0.0250	2.20	6.21	3.43	0.69
GRANITE CRK NO. 3	2	95.30	4.00	1.50	1.00	0.045	0.0270	2.20	6.42	3.71	0.74
GRANITE CRK NO. 3	50	350.21	4.00	1.50	1.00	0.045	0.0270	4.20	9.01	7.08	1.42
SUNFLOWER CREEK	2	134.81	18.00	7.50	5.00	0.045	0.0340	1.10	4.93	2.33	0.47
SUNFLOWER CREEK	50	485.02	18.00	7.50	5.00	0.045	0.0340	2.10	7.42	4.46	0.89
MARK'S CREEK	2	114.67	10.00	2.25	8.00	0.040	0.0080	1.70	3.60	0.85	0.17
MARK'S CREEK	50	599.69	10.00	2.25	8.00	0.040	0.0080	3.70	5.60	1.85	0.37
BROWN'S CREEK	2	99.95	11.00	4.50	2.50	0.040	0.0060	1.80	3.21	0.67	0.13
BROWN'S CREEK	50	399.79	11.00	4.50	2.50	0.040	0.0060	3.60	4.71	1.35	0.27
LOWE	2	440.08	7.00	2.50	6.50	0.045	0.0500	2.50	9.65	7.80	1.56
LOWE	50	1160.64	7.00	2.50	6.50	0.045	0.0500	3.90	12.12	12.17	2.43
POOP	2	10.85	8.00	4.75	2.00	0.045	0.0590	0.40	2.90	1.47	0.29
POOP	50	35.02	8.00	4.75	2.00	0.045	0.0590	0.70	4.83	2.58	0.52
PINE CREEK	2	250.26	10.00	4.50	5.00	0.045	0.0500	1.70	8.14	5.30	1.06
PINE CREEK	50	664.77	10.00	4.50	5.00	0.045	0.0500	2.80	10.19	8.74	1.75
HAIGHT CREEK	2	190.44	17.00	11.25	0.75	0.040	0.0050	2.10	3.06	0.66	0.13
HAIGHT CREEK	50	440.08	17.00	11.25	0.75	0.040	0.0050	3.10	3.99	0.97	0.19
EAMES CREEK	2	280.48	14.00	3.00	1.75	0.040	0.0040	3.30	3.89	0.82	0.16
EAMES CREEK	50	639.98	14.00	3.00	1.75	0.040	0.0040	5.00	4.95	1.25	0.25

APPENDIX E

CULVERT DESIGN SHEETS

LIST OF SYMBOLS AND DIMENSIONS

Q2	Two year flood, in cubic feet per second (cfs)
Q50	Fifty year flood, in cubic feet per second (cfs)
Vb	Culvert barrel velocity, in feet per second (fps)
HW	Headwater at culvert inlet, in feet (ft)
R	Rise of culvert, in feet (ft)
Nb	Manning's roughness value for the culvert barrel
S	Stream channel slope, in feet per foot (ft/ft)
D50	Particle size from gradation curve such that 50 percent of the mixture is finer by weight, in feet (ft)
D	Pipe diameter or rise, in feet (ft)
Ke	Culvert inlet loss coefficient
H	Energy head for culvert flowing full, in feet (ft)
dc	Critical depth, in feet (ft)
TW	Culvert tailwater, in feet (ft)
ho	Height of hydraulic grade line above outlet invert, in feet (ft)
L	Culvert barrel length, in feet (ft)
So	Culvert barrel slope, in feet (ft)

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

PROJECT NAME: 1-A
NUMBER

Mt. Scott Creek — 2.65 SQUARE MILES
STREAM NAME — DRAINAGE AREA

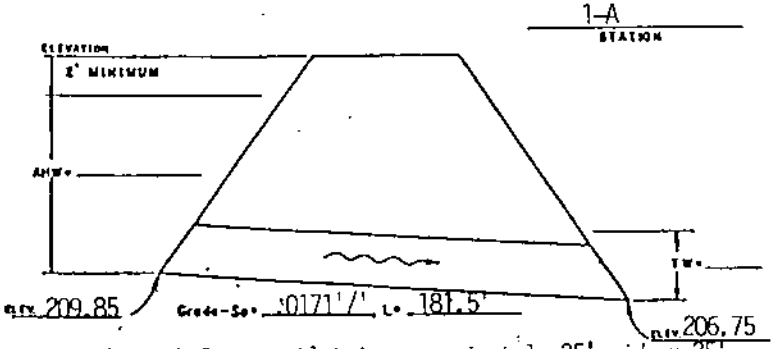
USGS Quad - "Gladstone, Oregon"
MAP

LOCATION: 3 SECTION, 2S TOWNSHIP, 2E RANGE, MERIDIAN

DESIGNED BY: Browning — DATE: 11/3/88
CHECKED BY — DATE

Q_{*2} 110 cfs — TW_{*2} 1.7'

Q_{*50} 330 cfs — TW_{*50} 3.0'



REMARKS: Scour hole at outlet is approximately 25' wide x 25' long x 2-1/2' deep.

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVE-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	METAL PIPE: STRUCTURAL PLATE (MITERED)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END SECTION	SIZE D (FEET) ①	Q	HEADWATER COMPUTATION: INLET CONTROL $\frac{HW}{D}$	INLET CONTROL HW	OUTLET CONTROL $HW = H + h_o - LS_o$: K_e	H	d_c	$\frac{d_c + D}{2}$	TW ①	h_o ①	LS_o	HW	OUTLET $\frac{HW}{D}$	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
K_e Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	①															
Concrete Box Culvert																							
10'-0" (span) x 8'-0" Rise with 1'-0" high baffles for 1/2 the span																							
Wing Walls at 39° angle								7	110	0.33	2.6	0.4	0.1	1.5	4.8	1.7	4.8	3.1	1.8	0.2	2.6	11	Barrel Velocity*
Wing Walls at 39° angle								7	330	0.7	5.6	0.4	0.5	3.3	5.7	3.0	5.7	3.1	3.1	0.4	5.6	15	Barrel Velocity*

SUMMARY AND RECOMMENDATIONS

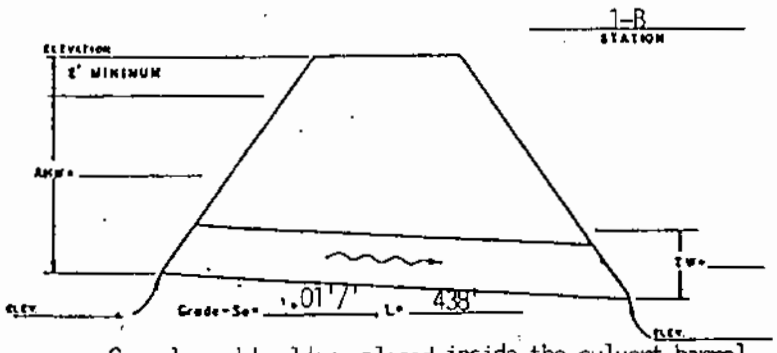
*Average velocity in unbaffled culvert span.
Due to high outlet velocities and high scour potential, the culvert outlet appears to be a potential barrier to fish passage through the culvert.

① USE CULVERT DIAMETER FOR ROUND PIPES. USE RISE DIMENSION FOR ARCH CULVERTS.
② TIED TO US DATUM, LEAVE COLUMN BLANK.
③ h_o IS THE LESSER OF $\frac{d_c + D}{2}$ AND TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

PROJECT NAME	1-B
Newell Creek	2.10
STREAM NAME	DRAINAGE AREA (SQUARE MILES)
MAP	USGS Quad - "Oregon City, Oregon"
LOCATION	32/33 (SECTION) 2S (TOWNSHIP) 2E (RANGE) (MERIDIAN)
DESIGNED BY	Browning
DATE	11/3/88
CHECKED BY	
DATE	
Q_{-2}	95 cfs
TW_{-2}	1.6'
Q_{-50}	275 cfs
TW_{-50}	2.8'



REMARKS: Gravel and boulders placed inside the culvert barrel.

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVE-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	METAL PIPE: STRUCTURAL PLATE (CORRUGATED)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END SECTION	SIZE D (FEET)	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL HW=H+h_o-LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	HEADWATER HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
Ke Coefficient→	0.2	0.9	0.7	0.7	0.5	0.7	0.5	①															
14' diameter pipe set approximately 3' below the natural stream bed.																								
Use equivalent 15'-7" x 10'-6" Pipe-Arch																								
							X	10.5	95	0.2	2.1	0.5	0.10	1.0	5.7	1.6	5.7	4.4	1.4	0.1	2.1	4.0	Barrel Velocity
							X	10.5	275	0.4	4.2	0.5	.50	1.6	6.0	2.8	6.0	4.4	2.1	0.2	4.2	6.0	Barrel Velocity

SUMMARY AND RECOMMENDATIONS

For Q2 = 95 cfs Vb = 4.0 fps @ db = 2.0 feet (n = 0.045)
For Q50 = 175 cfs Vb = 6.0 fps @ db = 3.7 feet (n = 0.045)

① USE CULVERT DIAMETER FOR ROUND PIPES
USE RISE DIMENSION FOR ARCH CULVERTS

② SIZE IF IS KNOWN, LEAVE COLUMN BLANK

③ h_o IS THE DISTANCE OF FULL AREA IN

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

PROJECT NAME: 1-C NUMBER

STREAM NAME: Cool Creek DRAINAGE AREA: 1.65 SQUARE MILES

MAP: USGS Quad - "Rhododendron, Oregon"

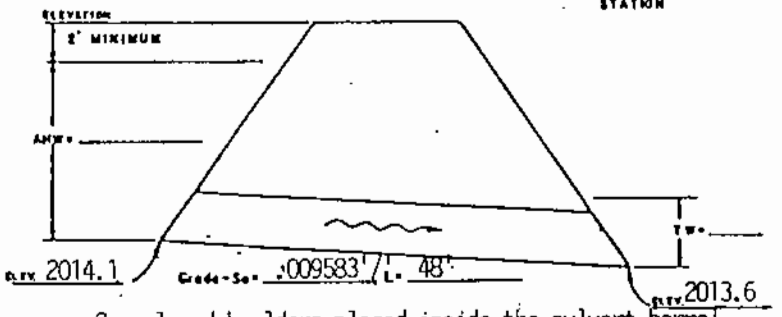
LOCATION: SECTION 24 TOWNSHIP 3S RANGE 7E MERIDIAN

DESIGNED BY: Browning DATE: 11/3/88

CHECKED BY DATE

Q_{Q2} = 145 cfs TW_{Q2} = 2.0'

Q_{Q50} = 365 cfs TW_{Q50} = 3.3'



REMARKS: Gravel and boulders placed inside the culvert barrel.

Log and rock pools constructed downstream from the culvert outlet.

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVE-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	METAL PIPE: STRUCTURAL PLATE (INTERIOR)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END SECTION	SIZE D (FEET)	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL HW=H+h_o-LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
K_e Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	①								①	①						
14.7' span x 9.5' + rise arch with top of footing approximately 4" below the natural stream bed.																							
Use equivalent 14'-0" x 5'-7" arch																							
		X						5.6	145	0.45	2.5	0.9	0.5	1.6	3.6	2.0	3.6	.46	3.6	0.6	3.6	5.6	Outlet velocity based upon TW
		X						5.6	365	1.0	5.6	0.9	2.5	2.8	4.2	3.3	4.2	.46	6.2	1.1	6.2	8.6	Outlet velocity based upon TW

SUMMARY AND RECOMMENDATIONS

For Q2 = 145 cfs Vb = 4.6 fps @ db = 2.5 ft. (n = .045) in the culvert barrel.
For Q50 = 365 cfs Vb = 6.3 fps @ db = 5.6 ft. (n = .045) in the culvert barrel.

Note: The culvert barrel depth and velocity conditions are probably more representative of the outlet conditions than those based upon the tail water depth.

① USE CULVERT DIAMETER FOR ROUND PIPES. USE RISE DIMENSION FOR ARCH CULVERTS ② CHECK TW IS KNOWN, LEAVE COLUMN BLANK ③ h_o IS THE LARGER OF $\frac{d_c+D}{2}$ AND TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

PROJECT NAME: 1-D
NUMBER

STREAM NAME: Lost Creek
DRAINAGE AREA: 3.2 SQUARE MILES

MAP: USGS Quad - "Bull Run Lake, Oregon"

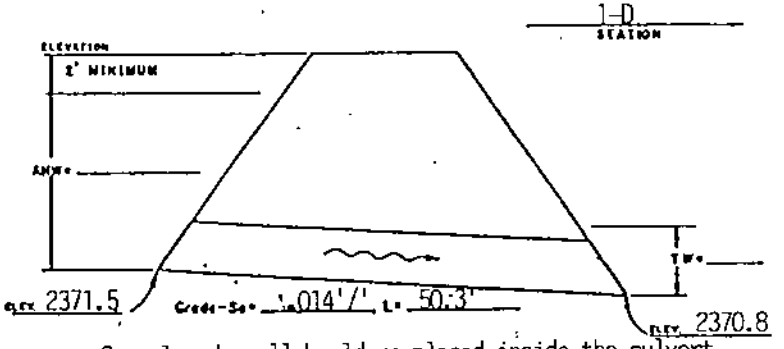
LOCATION: 21 SECTION, 2S TOWNSHIP, 8E RANGE, MERIDIAN

DESIGNED BY:
DATE:

CHECKED BY: Browning
DATE: 11/3/88

Q_{*2} = 255 cfs TW_{*2} = 2.1'

Q_{*50} = 650 cfs TW_{*50} = 3.5'



REMARKS: Gravel and small boulders placed inside the culvert barrel.

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVE-END PROJECTING	METAL PIPE HEADWALLS: PROJECTING	MITERED	STRUCTURAL PLATE (UNIFORM)	VERTICAL	MITERED	END SECTION	SIZE D (FEET)	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	HW	OUTLET CONTROL HW=H+h_o-LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
K_e Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	①								②	②						
18.2' span x 5.6' rise arch with exposed concrete footings (2.5' to 3.5' vertical exposure)																							
Use equivalent 18.2' span x 9.1' rise																							
		X						9.1	255	0.35	3.2	0.9	0.5	2.0	5.6	2.1	5.6	0.7	5.4	0.59	5.4	6.5	Outlet velocity based upon TW
		X						9.1	655	0.65	5.9	0.9	1.3	3.5	6.3	3.5	6.3	0.7	6.9	0.75	6.9	11.2	Outlet velocity based upon TW

SUMMARY AND RECOMMENDATIONS

For Q2 = 255 cfs Vb = 5.8 fps @ db = 2.5 ft. (n = 0.045) in the culvert barrel.
For Q50 = 650 cfs Vb = 8.2 fps @ db = 4.7 ft. (n = 0.045) in the culvert barrel.

Note: The culvert barrel depth and velocity conditions are probably more prepresentative of the outlet conditions than those based upon tail water depth.

① USE CULVERT DIMENSION FOR ROUND PIPES
USE RISE DIMENSION FOR ARCH CULVERTS

② TW=0 IS NORMAL, LIMIT CONTROL DEPTH

③ h_o IS THE DISTANCE OF HGL AND TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

C-7 (PROJECT NAME) (NUMBER)

Polallie Creek (STREAM NAME) 4.33 (DRAINAGE AREA) SQUARE MILES

USGS Quad - "Dog River" (MAP)

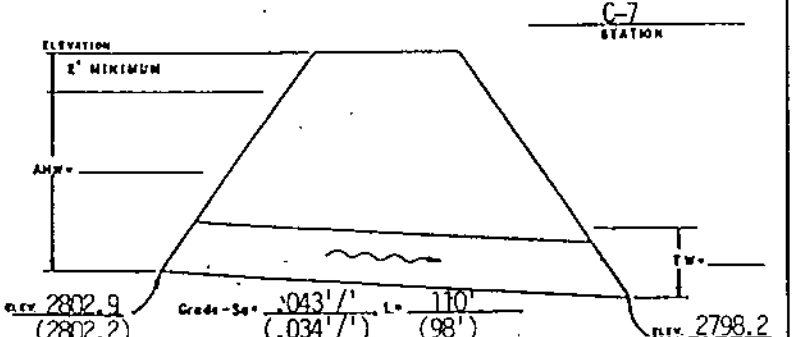
5 (SECTION) 2S (TOWNSHIP) 10E (RANGE) (MERIDIAN) (LOCATION)

Browning (DESIGNED) 11/3/88 (DATE)

(CHECKED BY) (DATE)

Q_{*2} 425 cfs TW_{*2} 3.3'

Q_{*50} 1090 cfs TW_{*50} 4.7'



REMARKS: The values in parentheses are for the 84" CMP.

2'+ deep scour hole is located at the outlet.

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVE-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	STRUCTURAL PLATE (CORNERS)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END-SECTION	SIZE D (FEET)	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL HW=H+h_o-LS$_o$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS$_o$	HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
K_e Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	①								①	①						
12.7' x 7.25' CMP-arch with concrete-lined invert. Also 84" CMP flood relief pipe.																							
12.7' x 7.25'			X					7.25	690	1.3	9.4	0.7	3.0	5.0	6.1	4.7	6.1	4.7	4.4	0.6	9.4	29.5	
84"			X					7	400	1.4	9.8	0.7	4.5	5.25	6.1	3.3	6.1	3.3	7.3	1.0	9.8	19.0	
12.7' x 7.25'			X					7.25	625	0.6	4.4	0.7	0.5	3.0	5.1	4.7	5.1	4.7	0.9	0.1	4.4	21.5	
84"			X					7	160	0.7	4.9	0.7	0.7	3.3	5.2	3.3	5.2	3.3	2.6	0.4	4.9	15.0	

SUMMARY AND RECOMMENDATIONS

For Q2 = 265 cfs Vb = 21.5 fps @ db = 1.5 ft. (n = 0.015) for 12.7'x 7.25' pipe arch barrel.
For Q50 = 690 cfs Vb = 29.5 fps @ db = 2.2 ft. (n = 0.015) for 12.7'x 7.25' pipe arch barrel.
For Q2 = 160 cfs Vb = 15 fps @ db = 2.3 ft. (n = 0.024) for 84" CMP culvert barrel.
For Q50 = 400 cfs Vb = 19 fps @ db = 4.0 ft. (n = 0.024) for 84" CMP culvert barrel.

① USE CULVERT DIAMETER FOR ROUND PIPES. USE RISE DIMENSION FOR ARCH CULVERTS. ② SHOE TO BE BALANCED, LEAVE COLUMN BLANK. ③ h_o IS THE LARGER OF $\frac{d_c+D}{2}$ AND TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

14-A (PROJECT NAME / NUMBER)

Mottet Creek (STREAM NAME) 10.8 (DRAINAGE AREA) SQUARE MILES

USGS Quad - "Jubilee Lake" (MAP)

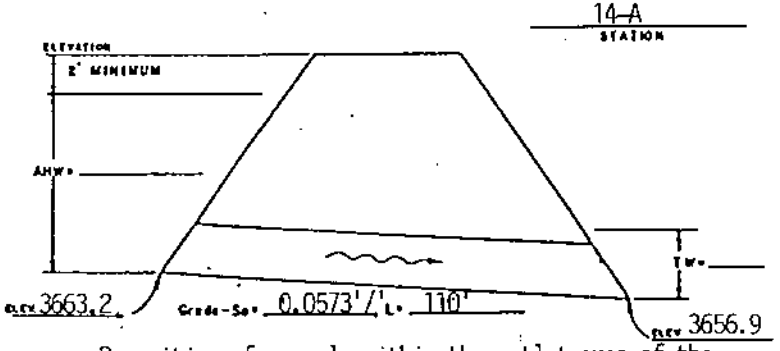
33 (SECTION) 4N (TOWNSHIP) 39E (RANGE) (MERIDIAN) (LOCATION)

(DESIGNED) (DATE)

Browning (CHECKED BY) 11/7/88 (DATE)

Q_{-2} 125 cfs TW_{-2} 3.0'

Q_{-50} 375 cfs TW_{-50} 4.9'



REMARKS: Deposition of gravels within the outlet area of the culvert. Deposition is due to pools formed by log barriers.

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVE-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	STRUCTURAL PLATE (UNIFORM)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END SECTION	SIZE D (FEET)	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL HW=H+h_o-LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW @	h_o @	LS_o	HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
K_e Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	@															
5'-8" x 7'-0"			X					7	125	.55	3.9	0.7	0.5	3.2	5.1	3.0	5.1	6.3	---	---	3.9	16.4	Barrel Velocity
5'-8" x 7'-0"			X					7	375	1.35	9.5	0.7	4.0	6.0	6.5	4.9	6.5	6.3	4.2	0.6	9.5	20.5	Barrel Velocity

SUMMARY AND RECOMMENDATIONS

For Q2 = 125 cfs Vb = 16.4 fps @ db = 2.0 ft. (n = 0.024) for the culvert barrel.
For Q50 = 375 cfs Vb = 20.5 fps @ db = 3.6 ft. (n = 0.024) for the culvert barrel.

Note: The culvert barrel velocity and depth are representative for the first 80'+ of culvert length. The 30' of culvert length near the outlet is controlled by the log pool. This is supported by the evidence of stream bed deposits within this area.

① USE CULVERT DIAMETER FOR ROUND PIPES USE RISE DIMENSION FOR ARCH CULVERTS ② MARK TW IS MANNING, LEAVE COLUMN BLANK ③ h_o IS THE DISTANCE OF d_c+D/2 ABV TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

PROJECT NAME: 14-B
NUMBER

STREAM NAME: Little Lookingglass Creek
DRAINAGE AREA: 18.2 square miles

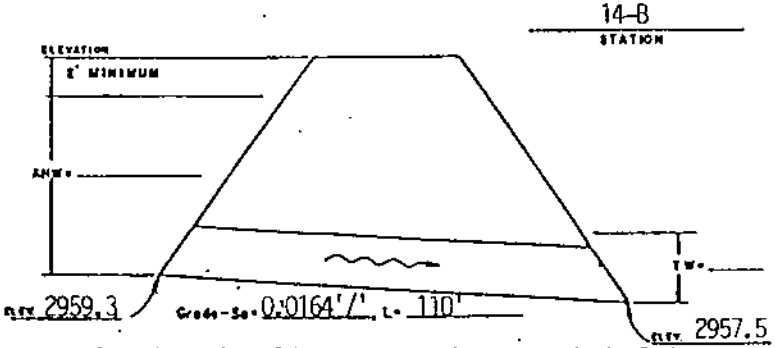
MAP: USGS Quad - "Jubilee Creek"

LOCATION: SECTION 2, TOWNSHIP 3N, RANGE 39E, MERIDIAN

DESIGNED:
CHECKED BY: Browning
DATE: 11/7/88

Q_2 = 195 cfs TW_2 = 1.4'

Q_{50} = 560 cfs TW_{50} = 2.1'



REMARKS: Gravels and boulders compose the stream bed of the arch.

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVE-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	METAL PIPE: STRUCTURAL PLATE (RIVETED)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END SECTION	SIZE D (FEET)	Q
K_e Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	①	
17'-6" 8'-1"	X	X						8.1	195
17'-6" 8'-1"	X	X						8.1	560

HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL HW=H+h_o-LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW ①	h_o ①	LS_o	HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
0.3	2.4	0.9	0.5	1.6	4.9	1.4	4.9	1.8	3.6	0.4	3.6	10.3	Based upon dc.
0.65	5.3	0.9	2.1	3.4	5.9	2.1	5.9	1.8	6.2	0.8	6.2	11.9	Based upon dc.

SUMMARY AND RECOMMENDATIONS

For Q2 = 195 cfs Vb = 6.0 fps @ db = 2.4 ft. (n = 0.045) for the culvert barrel.
For Q50 = 560 cfs Vb = 8.0 fps @ db = 4.6 ft. (n = 0.045) for the culvert barrel.

Note: Gabion weir may reduce outlet velocities during high flows. The barrel velocities are probably more representative of outlet velocities than those computed using dc.

① USE CULVERT DIAMETER FOR ROUND PIPES. USE RISE DIMENSION FOR ARCH CULVERTS.
② TW=D IS MINIMUM, LEAVE CHECKS BLANK.
③ h_o IS THE GREATER OF $\frac{d_c+D}{2}$ AND TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

PROJECT NAME: 15-A
NUMBER

STREAM NAME: Tamarack Gulch - trib. to Chesnimus Cr.
DRAINAGE AREA: 2.0 SQUARE MILES

MAP: USGS Quad - "Imnaha, Oregon"

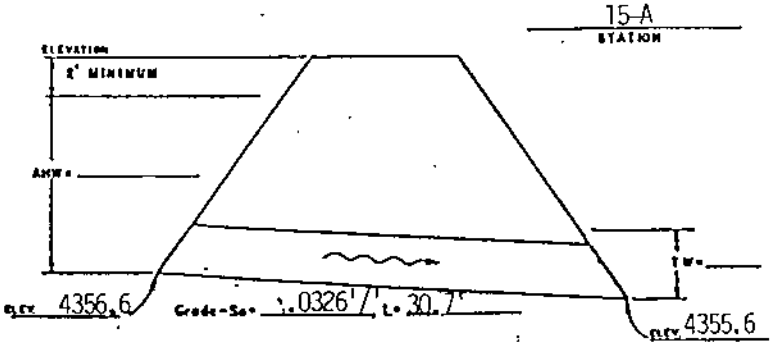
LOCATION: SECTION 34 TOWNSHIP 3N RANGE 47E MERIDIAN

DESIGNED BY:
DATE:

CHECKED BY: Browning
DATE: 11/7/88

Q_{2} = 11 cfs TW_{2} = 0.8'

Q_{50} = 55 cfs TW_{50} = 1.4'



REMARKS:

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVED-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	METAL PIPE: STRUCTURAL PLATE (INTERIOR)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END SECTION	SIZE D (FEET)	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL HW=H+h_o-LS$_o$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS$_o$	HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
Ke Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	ft								ft	ft						
6.0' x 3.9'	X						3.9	11	0.3	1.2	0.9	0.1	0.8	2.4	0.8	2.4	1.0	1.5	0.4	1.5	5.5	Barrel Velocity
6.0' x 3.9'	X						3.9	55	0.7	2.7	0.9	0.4	1.5	2.7	1.4	2.7	1.0	2.1	0.5	2.7	9.6	Barrel Velocity

SUMMARY AND RECOMMENDATIONS

For Q2 = 11 cfs Vb = 5.5 fps @ db = 0.5 ft. (n = 0.024) for the culvert barrel.
For Q50 = 55 cfs Vb = 9.6 fps @ db = 1.2 ft. (n = 0.024) for the culvert barrel.

Note: The culvert barrel does not significantly constrict the natural stream channel.

① USE CULVERT DIMENSION FOR ROUND PIPES
USE RISE DIMENSION FOR ARCH CULVERTS

② WHEN TW IS UNKNOWN, USE CRITICAL DEPTH

③ h_o IS USE GREATER OF $\frac{d_c+D}{2}$ AND TW

FS 96-134
(Rev. 8-73)

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

15-B
PROJECT NAME — NUMBER

South Fork Chesnimnus Creek — 4.8 SQUARE MILES
STREAM NAME — DRAINAGE AREA

USGS Quad - "Imnaha, Oregon"
MAP

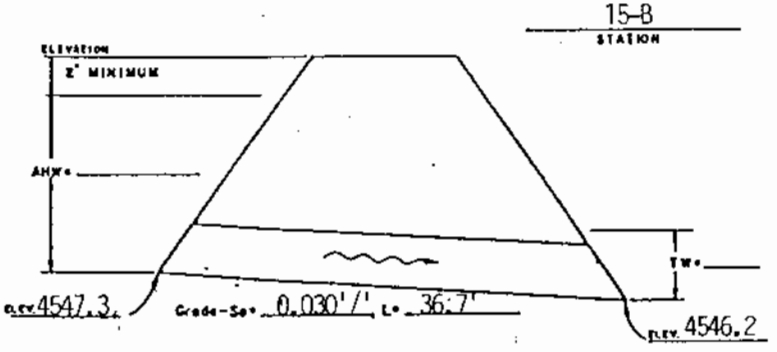
24 — 3N — 47E
LOCATION — SECTION — TOWNSHIP — RANGE — MERIDIAN

DESIGNED — DATE

Browning — 11/7/88
CHECKED BY — DATE

Q_{-2} 23 cfs — TW_{-2} 0.6'

Q_{-50} 107 cfs — TW_{-50} 1.3'



REMARKS:

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVE-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	STRUCTURAL PLATE (INTERIOR)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END SECTION	SIZE D FEET ①	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL K_e	OUTLET CONTROL H	OUTLET CONTROL d_c	OUTLET CONTROL $\frac{d_c+D}{2}$	OUTLET CONTROL TW ①	OUTLET CONTROL h_o ②	OUTLET CONTROL LS_o	OUTLET CONTROL HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
Ke Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	①															
6.7'			X					6.7	23	0.25	1.7	0.7	0.1	1.0	3.9	0.6	3.9	1.1	2.9	0.4	2.9	8.0	Barrel Velocity
6.7'			X					6.7	107	0.6	4.0	0.7	0.3	2.75	4.7	1.3	4.7	1.1	3.9	0.6	4.0	12.5	Barrel Velocity

SUMMARY AND RECOMMENDATIONS

For Q2 = 23 cfs Vb = 8.0 fps @ db = 0.9 ft. (n = 0.024) for the culvert barrel.
For Q50 = 107 cfs Vb = 12.5 fps @ db = 2.0 ft. (n = 0.024) for the culvert barrel.

Note: The culvert does not significantly constrict the natural stream channel.

① USE CULVERT DIAMETER FOR ROUND PIPES. USE RISE DIMENSION FOR ARCH CULVERTS. ② WHEN TW IS WARRANTED, USE CRITICAL DEPTH. ③ h_o IS THE LARGER OF $\frac{d_c+D}{2}$ AND TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

PROJECT NAME: D-6 — NUMBER

STREAM NAME: Devil's Run Creek — DRAINAGE AREA: 6.1 SQUARE MILES

MAP: USGS Quad - "Poison Point, Oregon"

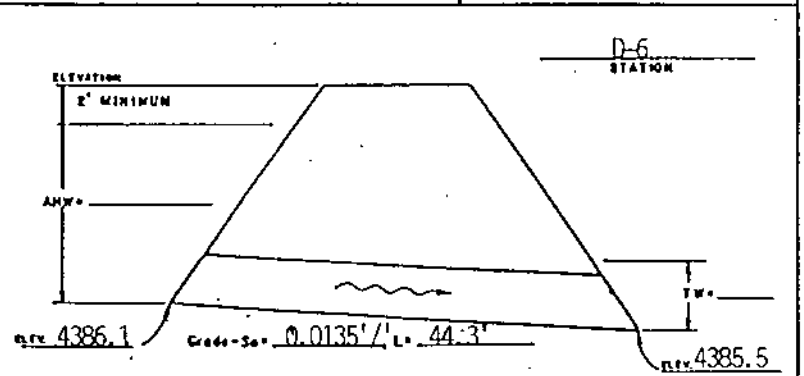
LOCATION: SECTION 3 — TOWNSHIP 3N — RANGE 47E — MERIDIAN

DESIGNED — DATE

CHECKED BY: Browning — DATE: 11/7/88

Q_{*2} 28 cfs — TW_{*2} 0.9'

Q_{*50} 129 cfs — TW_{*50} 1.9'



REMARKS:

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVED-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	METAL PIPE: STRUCTURAL PLATE (MITERED)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	HEADWALLS: END SECTION	SIZE D (FEET) ①	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL HW=H+h₀-LSo: K_e	H	d_c	$\frac{d_c+D}{2}$	TW ①	h_o ②	LS_o	HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
Ke Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	①								①	②						
10.2' x 4.5'			X					4.5	28	0.25	1.1	0.7	0.3	0.7	2.6	0.9	2.6	0.6	2.3	0.5	2.3	4.5	Based upon TW
10.2' x 4.5'			X					4.5	129	0.60	2.7	0.7	1.0	1.6	3.1	1.9	3.1	0.6	3.5	0.8	3.5	8.2	Based upon TW

SUMMARY AND RECOMMENDATIONS

For Q2 = 28 cfs Vb = 3.7 fps @ db = 1.1 ft. (n = 0.040) for the culvert barrel.
For Q50 = 129 cfs Vb = 5.7 fps @ db = 2.5 ft. (n = 0.040) for the culvert barrel.

Note: The barrel velocity is more representative of the outlet velocity for this culvert.

① USE CULVERT DIAMETER FOR ROUND PIPES. USE RISE DIMENSION FOR ARCH CULVERTS. ② WHEN TP IS KNOWN, LEAVE CULVERT BLANK. ② h_o IS THE GREATER OF $\frac{d_c+D}{2}$ AND TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

C-3
PROJECT NAME / NUMBER

Billy Creek — 10.7
STREAM NAME / DRAINAGE AREA — SQUARE MILES

USGS Quad - "Poison Point, Oregon"
MAP

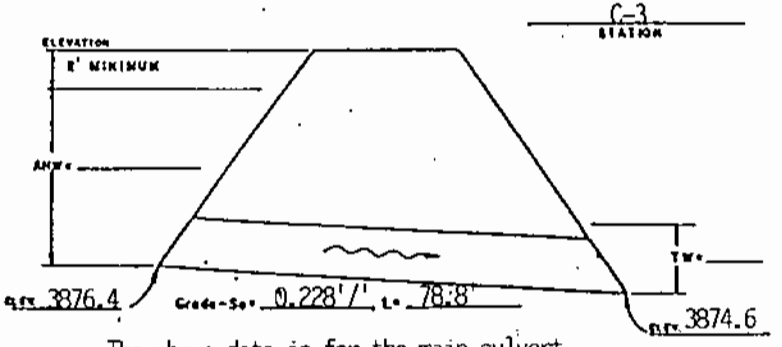
7 — 3N — 47E
LOCATION / SECTION / TOWNSHIP / RANGE / MERIDIAN

Browning — 11/8/88
DESIGNED BY / DATE

CHECKED BY / DATE

Q_{Q2} 45 cfs — TW_{Q2} 1.9'

Q_{Q50} 197 cfs — TW_{Q50} 3.0'



REMARKS: The above data is for the main culvert (6.3' x 5.0' pipe-arch)

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVE-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	METAL PIPE: STRUCTURAL PLATE (MITERED)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END SECTION	SIZE D (FEET)	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL K_e	OUTLET CONTROL H	OUTLET CONTROL d_c	OUTLET CONTROL $\frac{d_c+D}{2}$	OUTLET CONTROL TW ①	OUTLET CONTROL h_o ②	OUTLET CONTROL LS_o	OUTLET CONTROL HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
Ke Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	①															
6.3'x 5.0'			X					5	45	0.45	2.3	0.7	0.5	1.6	3.3	1.9	3.3	1.8	2.0	.40	2.3	4.5	Based upon TW
6.3'x 5.0'w/ 48" relief pipe			X					5	197	0.75	3.8	0.7	1.8	2.7	3.9	3.0	3.9	1.8	3.9	.80	3.9	7.1	Based upon TW

SUMMARY AND RECOMMENDATIONS

For Q2 = 45 cfs Vb = 8.0 fps @ db = 1.3 ft. (n = 0.024) for the culvert barrel.
For Q50 = 125 cfs Vb = 10.7 fps @ db = 2.0 ft. (n = 0.024) for the culvert barrel.

Assume the 48" relief pipe would carry 75 cfs during a Q50. TW is based upon weir elevation and height of flow above weir less the pipe outlet elevation.

① USE CULVERT DIAMETER FOR ROUND PIPES. USE RISE DIMENSION FOR ARCH CULVERTS. ② WHEN TW IS UNKNOWN, LEAVE COLUMN BLANK. ③ h_o IS THE DISTANCE BETWEEN dc+D/2 AND TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

B-2
PROJECT NAME — NUMBER

Camp Creek — 48.2 SQUARE MILES
STREAM NAME — DRAINAGE AREA

USGS Quad - "Imnaha, Oregon"
MAP

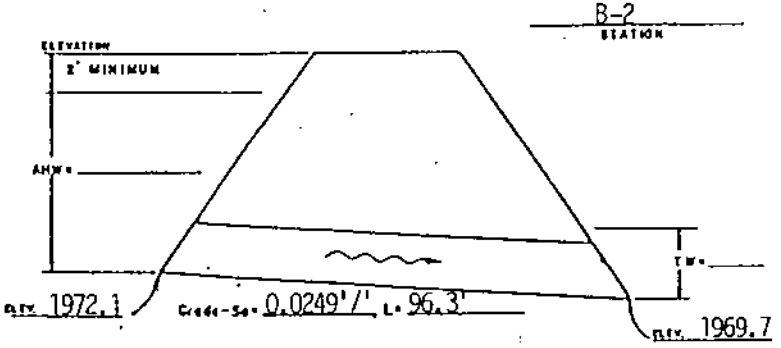
20 — 1N — 48E
LOCATION — SECTION — TOWNSHIP — RANGE — MERIDIAN

RESEARCH — DATE

Browning — 11/8/88
CHECKED BY — DATE

Q_2 153 cfs — TW_2 1.6'

Q_{50} 619 cfs — TW_{50} 3.3'



REMARKS:

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVED-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	METAL PIPE: STRUCTURAL PLATE (MITERED)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END SECTION	SIZE D (FEET)	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL HW=H+h_o-LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	-HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
K_e Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	①								②	②						
8' Dia. w/1' high baffles																							
Equiv.	7-1/2 Ø		X					7.5	153	0.6	4.5	0.7	0.4	3.3	5.4	1.6	5.4	2.4	3.4	0.45	4.5	8.4	Barrel Velocity
Equiv.	7-1/2 Ø		X					7.5	619	2.0	15.0	0.7	5.5	6.3	6.9	3.3	6.9	2.4	10.0	1.3	15.0	13.8	Barrel Velocity

SUMMARY AND RECOMMENDATIONS

For Q2 = 153 cfs Vb = 8.4 fps @ db = 3.2 ft. (n = 0.040) for the culvert barrel.
For Q50 = 619 cfs Vb = 13.8 fps @ db = 7.5 ft. (n = 0.040) for the culvert barrel.

Note: Baffles and sediment deposits reduce the barrel velocities due to increased roughness.

① USE CULVERT DIAMETER FOR ROUND PIPES. USE RISE DIMENSION FOR ARCH CULVERTS. ② FROM TW RATING CURVE, LARGE CULVERT FLOWS. ③ h_o IS THE DISTANCE BETWEEN CENTER OF OUTLET AND TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

C-4
PROJECT NAME — NUMBER

Doe Creek — 5.3' sq mi
STREAM NAME — DRAINAGE AREA

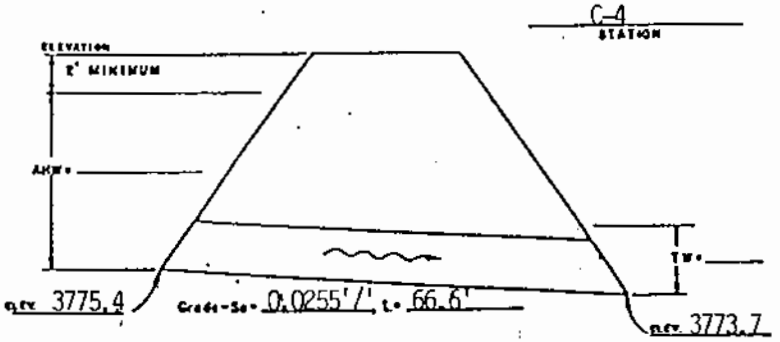
USGS Quad - "Elk Mt., Oregon"
MAP

LOCATION: 14 SECTION, 3N TOWNSHIP, 46E RANGE, WILLAMETTE MERIDIAN

Browning — 11/8/88
DESIGNED BY — DATE
CHECKED BY — DATE

Q_2 25 cfs — TW_2 1.1'

Q_{50} 116 cfs — TW_{50} 2.7'



REMARKS:

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVE-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	METAL PIPE: STRUCTURAL PLATE (CORRUGATED)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END-SECTION	SIZE D (FEET)	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL K_e	OUTLET CONTROL H	OUTLET CONTROL d_c	OUTLET CONTROL $\frac{d_c+D}{2}$	OUTLET CONTROL TW	OUTLET CONTROL h_o	OUTLET CONTROL LS_o	OUTLET CONTROL HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
Ke Coefficient→	0.2	0.9	0.7	0.7	0.5	0.7	0.5																
7.7' x 5.4'			X					5.4	25	.25	1.4	0.7	0.5	1.0	3.2	1.1	3.2	1.7	2.0	0.4	2.0	3.9	Based upon TW
7.7' x 5.4'			X					5.4	116	.65	3.5	0.7	0.8	2.2	3.8	2.7	3.8	1.7	2.9	0.5	3.5	6.1	Based upon TW

SUMMARY AND RECOMMENDATIONS

For Q2 = 25 cfs Vb = 6.5 fps @ db = 0.8 ft. (n = 0.024) for the culvert barrel.
For Q50 = 116 cfs Vb = 11.0 fps @ db = 1.6 ft. (n = 0.024) for the culvert barrel.

Note: TW is based upon weir elevation and height of flow above weir less the pipe outlet elevation.

① USE CULVERT DIAMETER FOR ROUND PIPES. USE RISE DIMENSION FOR ARCH CULVERTS
② WHEN TW IS UNKNOWN, COMPUTE COLUMN BLANK
③ h_o IS THE GREATER OF $\frac{d_c+D}{2}$ AND TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

D-8 (PROJECT NAME / NUMBER)

Gumboot Creek (STREAM NAME) 18.8 (DRAINAGE AREA, SQUARE MILES)

USGS Quad - "Homestead, Oregon" (MAP)

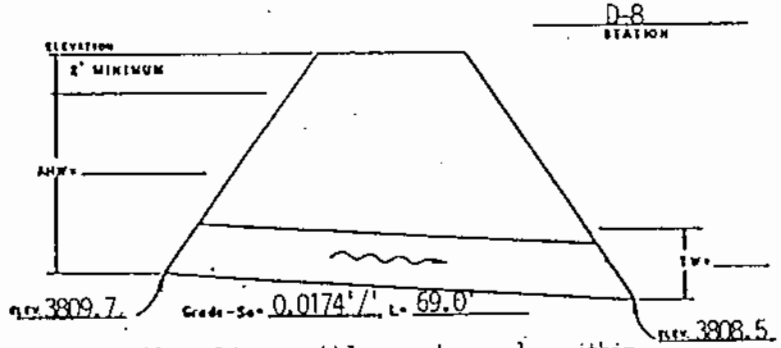
31 (SECTION) 4S (TOWNSHIP) 48E (RANGE) (LOCATION, MERIDIAN)

Browning (DESIGNED BY) 11/8/88 (DATE)

Browning (CHECKED BY) 11/8/88 (DATE)

Q_{Q2} = 142 cfs TW_{Q2} = 1.5'

Q_{Q50} = 444 cfs TW_{Q50} = 2.4'



REMARKS: Small boulders, cobbles, and gravels within the culvert barrel.

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVE-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	METAL PIPE: STRUCTURAL PLATE (MITERED)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END SECTION	SIZE D (FEET) ①	Q
Ke Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	①	
15.0' x 8.5' Open bottom arch w/3' of exposed footings.									
Equiv. 15.0' x 11.5'									
			X					11.5	142
			X					11.5	444

HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL HW=H+h_o-LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW ①	h_o ①	LS_o	-HW	INLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
0.25	2.9	0.7	0.25	2.3	6.9	1.5	6.9	1.2	6.0	0.5	6.0	5.8	Barrel Velocity
0.50	5.8	0.7	0.75	3.5	7.5	2.4	7.5	1.2	7.1	0.6	7.1	8.2	Barrel Velocity

SUMMARY AND RECOMMENDATIONS

For Q2 = 142 cfs Vb = 5.8 fps @ db = 2.4 ft. (n = 0.045) for the culvert barrel.
For Q50 = 444 cfs Vb = 8.2 fps @ db = 4.3 ft. (n = 0.045) for the culvert barrel.

① USE CULVERT DIAMETER FOR ROUND PIPES. USE RISE DIMENSION FOR ARCH CULVERTS. ② INLET ID IS MARKED, SOME CULVERT BLANK. ③ h_o IS THE GREATER OF $d_c+\frac{D}{2}$ OR TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

15-D
PROJECT NAME — NUMBER

Elk Creek — 25.5 SQUARE MILES
STREAM NAME — DRAINAGE AREA

USGS Quad - "Elk Mtn., Oregon"
MAP

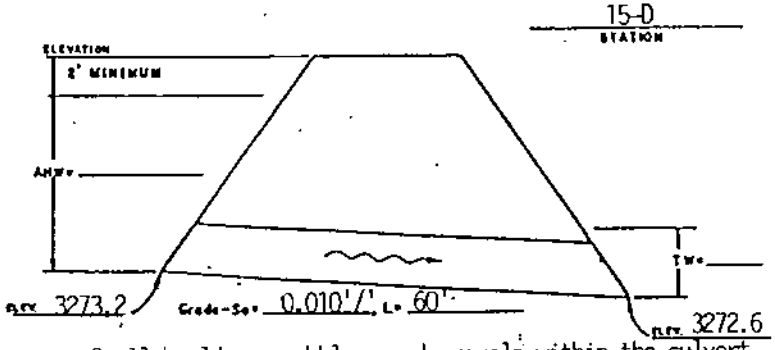
35 — 3N — 45E
LOCATION — SECTION — TOWNSHIP — RANGE — MERIDIAN

Browning — 11/8/88
DESIGNED BY — DATE

CHECKED BY — DATE

Q_{-2} 71 cfs — TW_{-2} 1.0'

Q_{-50} 333 cfs — TW_{-50} 2.2'



REMARKS: Small boulders, cobbles, and gravels within the culvert barrel.

SIZE (INCHES)	CULVERT DESCRIPTION: METAL PIPE — CONCRETE GROOVE-END PROJECTING	METAL PIPE — PROJECTING	METAL PIPE — MITERED	STRUCTURAL PLATE (CORRUGATED)	HEADWALLS — VERTICAL	HEADWALLS — MITERED	END-SECTION	SIZE D (FEET)	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL HW=H+h_o-LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
K_e Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	①								②	②						
13.9' x 0.1' with 1' of exposed footings Equiv. 13.9' x 7.1'																							
				X				7.1	71	.25	1.8	0.7	.2	1.4	4.3	1.0	4.3	0.6	3.9	0.5	3.9	3.9	Barrel Velocity
				X				7.1	333	.7	5.0	0.7	1.0	2.8	5.0	2.2	5.0	0.6	5.4	0.8	5.4	6.0	Barrel Velocity

SUMMARY AND RECOMMENDATIONS

For Q2 = 71 cfs Vb = 3.9 fps @ db = 1.8 ft. (n = 0.045) for the culvert barrel.

For Q50 = 333 cfs Vb = 6.0 fps @ db = 4.3 ft. (n = 0.045) for the culvert barrel.

① USE CULVERT DIAMETER FOR ROUND PIPES. USE RISE DIMENSION FOR ARCH CULVERTS.

② WHEN TW IS UNKNOWN, LEAVE COLUMN BLANK.

③ h_o IS THE LARGER OF $\frac{d_c+D}{2}$ OR TW

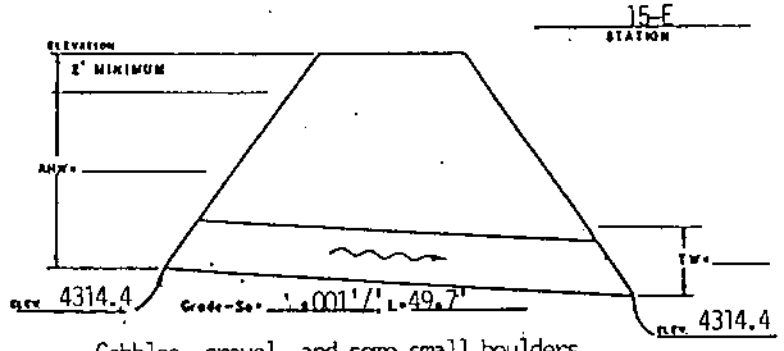
CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

PROJECT NAME: 15-E
NUMBER: 15-E
STREAM NAME: Chesnimus Creek
DRAINAGE AREA: 25.5 SQUARE MILES
MAP: USGS Quad - "Immaha, Oregon"
LOCATION: 21 SECTION, 3N TOWNSHIP, 4?E RANGE, WILLAMETTE MERIDIAN
DESIGNED BY:
DATE:
CHECKED BY: Browning
DATE: 11/8/88

Q_{*2} 91 cfs TW_{*2} 1.5'

Q_{*50} 381 cfs TW_{*50} 2.9'



REMARKS: Cobbles, gravel, and some small boulders within the culvert barrel.

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE BOX/C-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	STRUCTURAL PLATE (MITERED)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END SECTION	SIZE D (FEET)	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL K_e	OUTLET CONTROL H	OUTLET CONTROL d_c	OUTLET CONTROL $\frac{d_c+D}{2}$	OUTLET CONTROL TW	OUTLET CONTROL h_o	OUTLET CONTROL LS_o	OUTLET CONTROL HW	OUTLET CONTROL HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
Ke Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	0								0	0						
11' x 5.7'			X					5.7	91	0.4	2.3	0.7	0.5	1.1	3.4	1.5	3.4	0	3.9	0.7	3.9	1.8	Barrel Velocity
11' x 5.7'			X					5.7	381	1.1	6.3	0.7	2.7	4.0	4.8	2.9	4.8	0	7.5	1.3	7.5	7.6	Barrel Velocity

SUMMARY AND RECOMMENDATIONS

For Q2 = 91 cfs Vb = 1.8 fps @ db = 5.7 ft. (n = 0.04) for the culvert barrel.

For Q50 = 381 cfs Vb = 7.6 fps @ db = 5.7 ft. (n = 0.04) for the culvert barrel.

NOTE: Barrel velocity in this case = $\frac{Q}{\text{arch area}} = \frac{Q}{50 \text{ ft}^2}$

① USE CULVERT DIAMETER FOR ROUND PIPES. USE RISE DIMENSION FOR ARCH CULVERTS. ② WHEN TW IS UNKNOWN, USE CULVERT BLANK. ③ h_o IS THE LARGEST OF $\frac{d_c+D}{2}$ AND TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

15-F
PROJECT NAME — NUMBER

Crow Creek — 55.8
STREAM NAME — DRAINAGE AREA (SQUARE MILES)

USGS Quad - "Elk Mtn., Oregon"
MAP

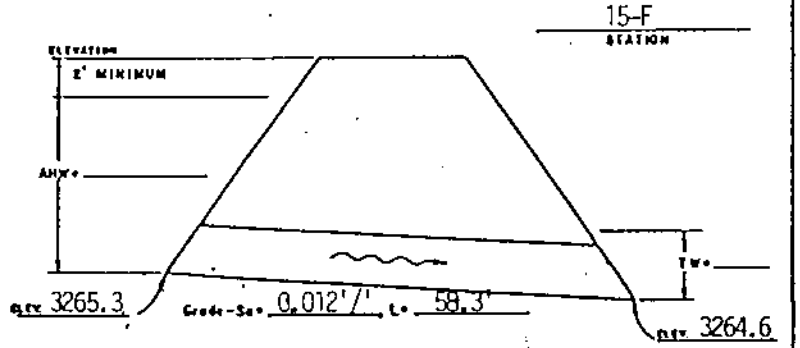
35 — 3N — 45E
LOCATION — SECTION — TOWNSHIP — RANGE — MERIDIAN

Browning — 11/8/88
DESIGNED BY — DATE

CHECKED BY — DATE

Q_{*2} 135 cfs — TW_{*2} 3.0'

Q_{*50} 603 cfs — TW_{*50} 5.2'



REMARKS:

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE BEVELED-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	METAL PIPE: STRUCTURAL PLATE (CORRUGATED)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END-SECTION	SIZE D (FEET) @	Q
Ke Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	@	
12.8' x 5.0'			X					5	135
12.8' x 5.0'			X					5	603

HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL HW* = H + h_o - LS_o: K_e	H	d_c	$\frac{d_c + D}{2}$	TW @	h_o @	LS_o	HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
0.5	2.5	0.7	0.5	1.5	3.3	3.0	3.3	0.7	3.1	0.6	3.1	3.9	Based upon TW
1.65	8.3	0.7	6.0	3.7	4.4	5.2	5.2	0.7	10.5	2.1	10.5	10.2	Full Barrel Flow

SUMMARY AND RECOMMENDATIONS

For Q2 = 135 cfs Vb = 5.4 fps @ db = 2.3 ft. (n = 0.040) for the culvert barrel.
For Q50 = 508 cfs Vb = 10.2 fps @ db = 5 ft. (n = 0.040) for the culvert barrel.

Assume the 48" relief pipe would carry 95 cfs during a Q50. For Q50, $Vb = \frac{Q50}{\text{Barrel X-Sect Area}}$

* USE CULVERT DIAMETER FOR ROUND PIPES. USE RISE DIMENSION FOR ARCH CULVERTS
** WHEN TW IS UNKNOWN, USE CRITICAL DEPTH
*** h_o IS THE DISTANCE BETWEEN EGL AND TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

PROJECT NAME: 13-A
NUMBER:

STREAM NAME: Meacham Creek - No. 1
DRAINAGE AREA: 16.2 SQUARE MILES

MAP: USGS Quad - "Meacham, Oregon"

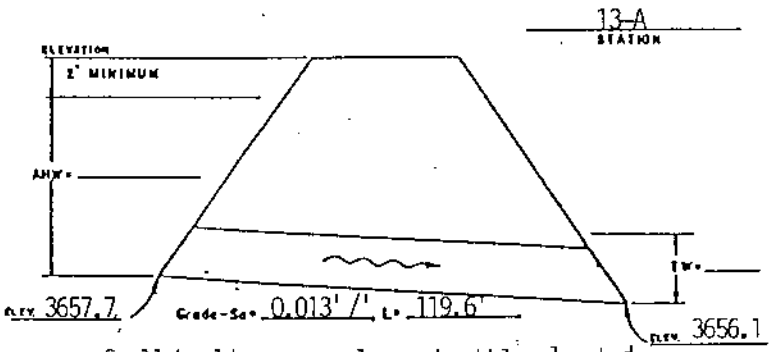
LOCATION: 3 SECTION, 1S TOWNSHIP, 35E RANGE, MERIDIAN

DESIGNER:
DATE:

CHECKED BY: Browning
DATE: 11/8/88

Q=2: 75 cfs TW=2: 1.6'

Q=50: 500 cfs TW=50: 4.5'



REMARKS: Small boulders, gravels, and cobbles located within barrel.

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE BEVELED-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	METAL PIPE: STRUCTURAL PLATE (INTEGRAL)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END-SECTION	SIZE D (FEET)	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL HW=H+h$_o$-LS$_o$: K$_e$	H	d$_c$	(d$_c$+D)/2	TW	h$_o$	LS$_o$	-HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
Ke Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	ø								ø	ø						
14' x 12.8' set approximately 2' below the existing stream bed.																							
Equivalent 10.8' rise by 12.8' span																							
			X					10.8	75	0.2	2.2	0.7	0.5	1.1	6.0	1.6	6.0	1.6	4.9	0.5	4.9	4.8	Barrel Velocity
			X					10.8	500	0.5	5.4	0.7	.75	3.2	7.0	4.5	7.0	1.6	6.2	0.6	6.2	7.6	Barrel Velocity

SUMMARY AND RECOMMENDATIONS

For Q2 = 75 cfs Vb = 4.8 fps @ db = 2.2 ft. (n = 0.045) for the culvert barrel.
For Q50 = 375 cfs Vb = 7.6 fps @ db = 4.9 ft. (n = 0.045) for the culvert barrel.

Assume the 10' x 8.8' (equiv. 9' ø) pipe would carry 125 cfs during Q50.

○ USE CULVERT DIAMETER FOR ROUND PIPES. USE RISE DIMENSION FOR ARCH CULVERTS.
◎ WHEN TW IS UNKNOWN, LEAVE COLUMN BLANK.
○ h_o IS THE LESSER OF $\frac{d_c+D}{2}$ AND TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

13-B
PROJECT NAME — NUMBER

Meacham Creek - No. 6 — 22.2 SQUARE MILES
STREAM NAME — DRAINAGE AREA

USGS Quad - "Meacham, Oregon"
MAP

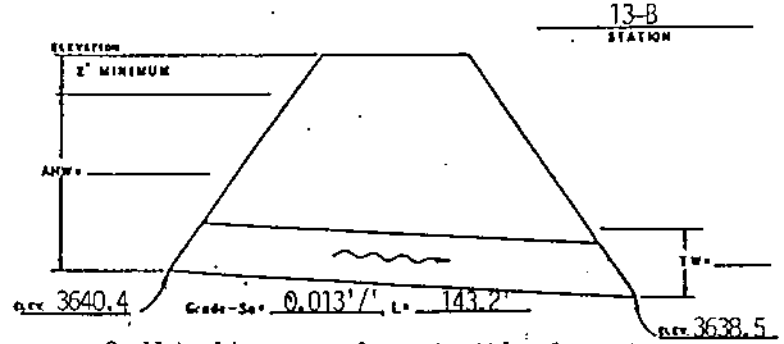
35 — 1N — 35E
LOCATION — SECTION — TOWNSHIP — RANGE — MERIDIAN

DESIGNED — DATE

Browning — 11/9/88
CHECKED BY — DATE

Q_{*2} 95 cfs — TW_{*2} 1.6'

Q_{*50} 625 cfs — TW_{*50} 4.1'



REMARKS: Small boulders, gravels, and cobbles located within barrel.

SIZE INCHES	CULVERT DESCRIPTION: CONCRETE GROOVE-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	STRUCTURAL PLATE (MITERED)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END-SECTION	SIZE D FEET ø	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL HW=H+h$_o$-LS$_o$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW ø	h_o ø	LS$_o$	HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
K_e Coefficient→	0.2	0.9	0.7	0.1	0.5	0.7	0.5	ø															
15' Ø set approximately 2' below the existing stream bed.																								
Equivalent 14.4' span by 13' rise																								
			X					13	95	0.2	2.6	0.7	0.2	1.3	7.2	1.6	7.2	1.9	5.5	.4	5.5	5.2	Barrel Velocity
			X					13	625	0.5	6.5	0.7	0.75	3.3	8.2	4.1	8.2	1.9	7.1	.6	7.1	8.0	Barrel Velocity

SUMMARY AND RECOMMENDATIONS

For Q2 = 95 cfs Vb = 5.2 fps @ db = 2.4 ft. (n = 0.045) for the culvert barrel.
For Q50 = 500 cfs Vb = 8.0 fps @ db = 5.3 ft. (n = 0.045) for the culvert barrel.

Assume the 10'Ø pipe would carry 125 cfs during a Q50.

* USE CULVERT DIAMETER FOR ROUND PIPES. USE RISE DIMENSION FOR ARCH CULVERTS
* TW=0 IF TW IS UNKNOWN, USE CULVERT CRITICAL DEPTH
* h_o IS THE GREATER OF $\frac{d_c+D}{2}$ OR TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

13-C
PROJECT NAME / NUMBER

Meacham Creek — 22.3 SQUARE MILES
STREAM NAME / DRAINAGE AREA

USGS Quad - "Meacham, Oregon"
MAP

35 — 1N — 35E
LOCATION: SECTION / TOWNSHIP / RANGE / MERIDIAN

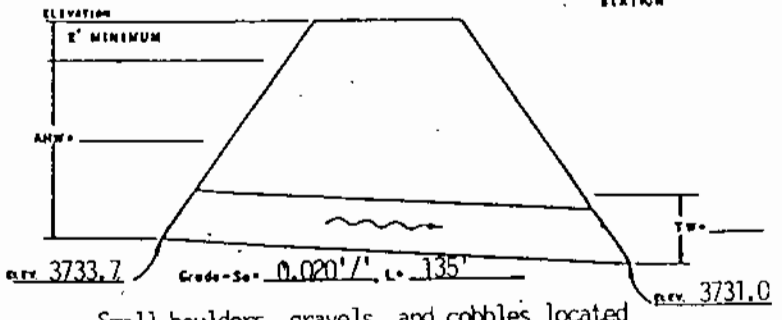
Browning — 11/9/88
DESIGNED BY / DATE

Checked By

$Q_{=2}$ 95 cfs — $TW_{=2}$ 1.4'

$Q_{=50}$ 625 cfs — $TW_{=50}$ 3.8'

13-C
STATION



REMARKS: Small boulders, gravels, and cobbles located within the barrel.

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVE-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	METAL PIPE: STRUCTURAL PLATE (CORNER)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END SECTION	SIZE D (FEET) ①	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL HW=H+h_o-LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW ②	h_o ②	LS_o	HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
K_e Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	②															
15' X 13.8' set approximately 2' below the existing stream bed																								
Equivalent 14' span X 13' rise																								
			X					13	95	0.2	2.6	0.7	0.2	1.3	7.1	1.4	7.1	2.7	4.6	0.4	4.6	6.0	Barrel velocity
			X					13	625	0.5	6.5	0.7	0.75	3.9	8.4	3.8	8.4	2.7	6.5	0.5	6.5	9.4	Barrel velocity

SUMMARY AND RECOMMENDATIONS

Q2 = 95 cfs Vb = 6.0 fps @ b = 2.0 ft. (n = 0.045) culvert barrel
Q50 = 500 cfs Vb = 9.4 fps @ db = 5.1 ft. (n = 0.045) culvert barrel

Assume the 10' Ø pipe would carry 125 cfs during a Q50.

① USE CULVERT DIAMETER FOR ROUND PIPES
USE RISE DIMENSION FOR ARCH CULVERTS

② WHEN TW IS UNKNOWN, USE CRITICAL DEPTH

③ h_o IS THE AVERAGE OF $\frac{d_c+D}{2}$ AND TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

PROJECT NAME: 13-D
NUMBER

STREAM NAME: Meacham Creek
DRAINAGE AREA: 22.4 SQUARE MILES

MAP: USGS Quad - "Meacham, Oregon"

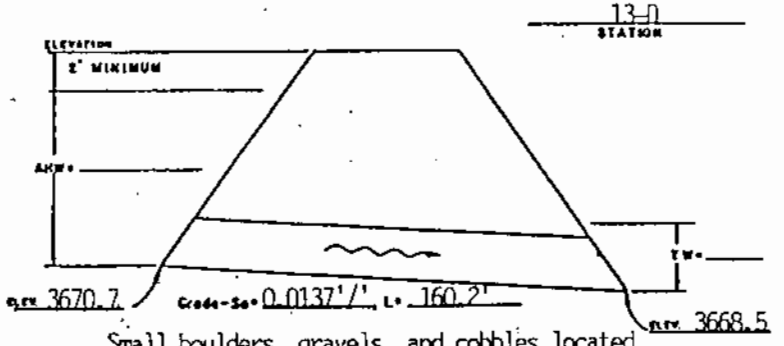
LOCATION: SECTION 35 TOWNSHIP 1N NAME 35E MERIDIAN

DESIGNER
DATE: 11/9/88

CHECKED BY
DATE

Q_2 = 95 cfs TW_2 = 1.5'

Q_{50} = 625 cfs TW_{50} = 4.1'



REMARKS: Small boulders, gravels, and cobbles located within the barrel.

SIZE (INCHES)	CULVERT DESCRIPTION: METAL PIPE CONCRETE GROOVE-END PROJECTING	METAL PIPE PROJECTING	METAL PIPE MITERED	METAL PIPE STRUCTURAL PLATE (MITERED)	HEADWALLS VERTICAL	HEADWALLS MITERED	END SECTION	SIZE D (FEET)	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL HW=H+h_o-LS_o K_e	H	d_c	$\frac{d_c+D}{2}$	TW (ft)	h_o (ft)	LS_o	HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
Ke Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	(ft)															
20' X 20' squash pipe set approximately 3' to 5' below the existing stream bed																								
Equivalent 20' span X 16' rise																								
			X					16	95	0.1	1.6	0.7	0.1	1.6	8.8	1.5	8.8	2.2	6.7	0.4	6.7	5.3	Barrel velocity
			X					16	625	0.4	6.4	0.7	0.6	3.2	9.1	4.1	9.1	2.2	7.5	0.5	7.5	8.7	Barrel velocity

SUMMARY AND RECOMMENDATIONS

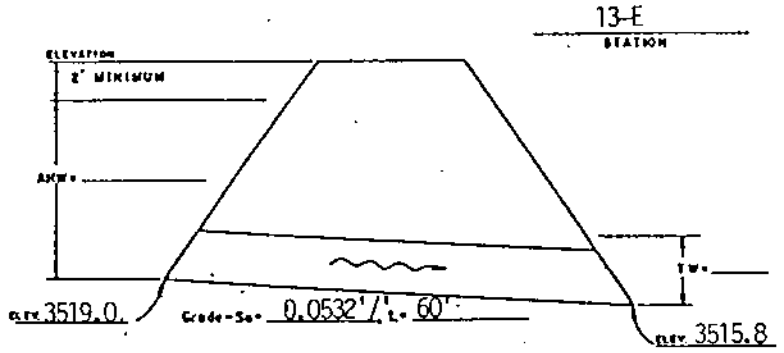
Q2 = 95 cfs Vb = 5.3 fps @ db = 2.0 ft. (n = 0.045) culvert barrel
Q50 = 625 cfs Vb = 8.7 fps @ db = 5.1 ft. (n = 0.045) culvert barrel

① USE CULVERT DIAMETER FOR ROUND PIPES. USE RISE DIMENSION FOR ARCH CULVERTS.
② TW=T IF IS KNOWN, OTHERWISE COMPUTE BLANK.
③ h_o IS THE LARGER OF $\frac{d_c+D}{2}$ AND TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

PROJECT NAME: 13-E
NUMBER:
STREAM NAME: Sheep Creek
DRAINAGE AREA: 3.0 SQUARE MILES
MAP: USGS Quad - "Meacham, Oregon"
LOCATION: SECTION 35 TOWNSHIP 1N RANGE 35E MERIDIAN
DESIGNED BY:
DATE:
CHECKED BY: Browning
DATE: 11/9/88
Q_{*2} 20 cfs TW_{*2} 0.7'
Q_{*50} 150 cfs TW_{*50} 2.3'



REMARKS:

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVED-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	METAL PIPE: STRUCTURAL PLATE (MITERED)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END SECTION	SIZE D (FEET) ①	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL $HW = H + h_o - LS_o$: K_e	H	d_c	$\frac{d_c + D}{2}$	TW ①	h_o ①	LS_o	-HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
Ke Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5																
7'Ø			X					7	20	0.2	1.4	0.7	0.1	1.0	4.0	0.7	4.0	3.2	0.9	0.1	1.4	9.0	Barrel velocity
7'Ø			X					7	150	0.7	4.9	0.7	0.6	3.2	5.1	2.3	5.1	3.2	2.5	0.4	4.9	16.0	Barrel velocity

SUMMARY AND RECOMMENDATIONS

Q2 = 20 cfs Vb = 9.0 fps @ db = 0.8 ft. (n = 0.024) culvert barrel
Q50 = 150 cfs Vb = 16.0 fps @ db = 2.2 ft. (n = 0.024) culvert barrel

① USE CULVERT DIAMETER FOR ROUND PIPES. USE RISE DIMENSION FOR ARCH CULVERTS. ② WHEN TW IS UNKNOWN, ASSUME CULVERT FLOWS. ③ h_o IS THE DISTANCE FROM $\frac{d_c + D}{2}$ TO TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

PROJECT NAME: 12-A
NUMBER

STREAM NAME: Canyon Creek
DRAINAGE AREA: 27.8 SQUARE MILES

LOCATION: USGS Quad - "Seneca, Oregon"

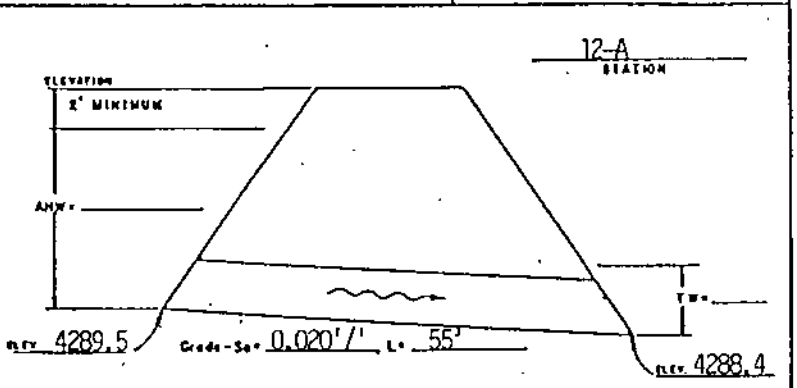
SECTION: 2 TOWNSHIP: 16S RANGE: 32E MERIDIAN: W.M.

DESIGNED BY:
DATE:

CHECKED BY: Browning
DATE: 11/10/88

Q_{*2} = 215 cfs TW_{*2} = 2.7'

Q_{*50} = 675 cfs TW_{*50} = 4.8'



REMARKS:

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVE-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	STRUCTURAL PLATE (CORRUGATED)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END SECTION	SIZE D (FEET) ①	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL HW=H+h_o-LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW ①	h_o ①	LS_o	HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
Ke Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	①															
12.6' X	8.1'		X					8.1	215	0.6	4.9	0.7	0.5	2.5	5.3	2.7	5.3	1.1	4.7	0.6	4.9	11.1	Barrel velocity
12.6' X	8.1'		X					8.1	675	1.2	9.7	0.7	2.0	4.7	6.4	4.8	6.4	1.1	7.3	0.9	9.7	15.6	Barrel velocity

SUMMARY AND RECOMMENDATIONS

Q2 = 215 cfs Vb = 11.1 fps @ db = 2.0 ft. (n = 0.024) culvert barrel

Q50 = 675 cfs Vb = 15.6 fps @ db = 3.9 ft. (n = 0.024) culvert barrel

① USE CULVERT DIAMETER FOR ROUND PIPES. USE RISE DIMENSION FOR ARCH CULVERTS. ② RISE IN IS VARIABLE, USE CROWN RISE. ③ h_o IS THE DISTANCE OF $\frac{d_c+D}{2}$ ABOVE TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

PROJECT NAME: 12-B
NUMBER

STREAM NAME: Middle Fork of Canyon Creek
DRAINAGE AREA: 11.9 REMARK INLET

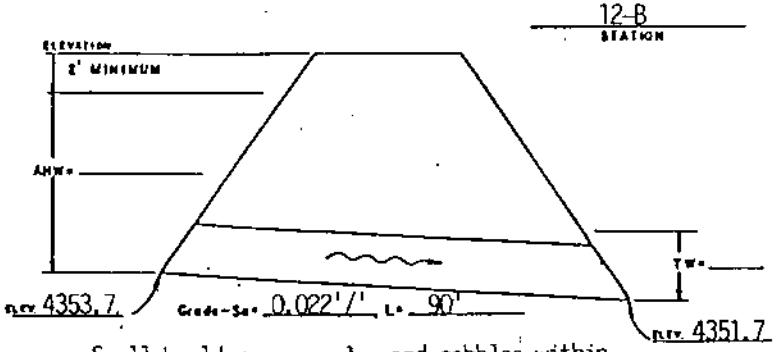
MAP: USGS Quad - "Seneca, Oregon"

LOCATION: 2 SECTION, 16S TOWNSHIP, 32E RANGE, MERIDIAN

DESIGNED: Browning
CHECKED BY
DATE: 11/9/88

Q_{*2} 110 cfs TW_{*2} 1.4'

Q_{*50} 350 cfs TW_{*50} 2.5'



REMARKS: Small boulders, gravels, and cobbles within the barrel.

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE BOOT-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	STRUCTURAL PLATE (MITERED)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END SECTION	SIZE D (FEET)	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL HW=H+h_o-LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
Ke Coefficient→	0.2	0.9	0.7	0.7	0.5	0.7	0.5	①								①	①						
13.5' X 8.5' set approximately 2.0' below the existing stream bed																							
Equivalent 6.5' rise by 13.5' span																							
				X				6.5	110	0.4	2.6	0.7	0.5	1.3	3.9	1.4	3.9	2.0	2.4	0.4	2.6	6.2	Barrel velocity
				X				6.5	350	0.8	5.2	0.7	2.1	3.2	4.8	2.5	4.8	2.0	4.9	0.7	5.2	8.6	Barrel velocity

SUMMARY AND RECOMMENDATIONS

Q2 = 110 cfs Vb = 6.2 fps @ db = 1.8 ft. (n = 0.045) culvert barrel
Q50 = 350 cfs Vb = 8.6 fps @ db = 3.3 ft. (n = 0.045) culvert barrel

① USE CULVERT DIAMETER FOR ROUND PIPES
USE RISE DIMENSION FOR ARCH CULVERTS

② WHEN TW IS UNKNOWN, LEAVE COLUMN BLANK

③ h_o IS THE LARGER OF $\frac{d_c+D}{2}$ AND TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

PROJECT NAME: 12-C
NUMBER

STREAM NAME: Canyon Creek
DRAINAGE AREA: 11.5 SQUARE MILES

MAP: USGS Quad - "Seneca, Oregon"

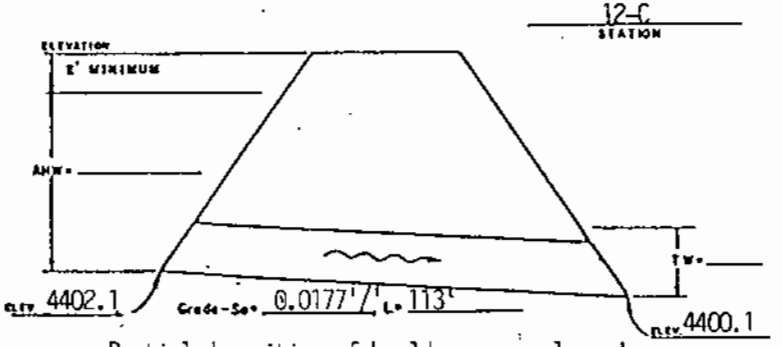
LOCATION: 1 SECTION 16S TOWNSHIP 32E RANGE MERIDIAN

DESIGNED: Browning
DATE: 11/9/88

CHECKED BY
DATE

Q_2 = 105 cfs TW_2 = 2.0'

Q_{50} = 345 cfs TW_{50} = 3.6'



REMARKS: Partial deposition of boulders, gravel, and cobbles within the culvert barrel.

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE BEVELED-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	STRUCTURAL PLATE (CORNER)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END SECTION	SIZE D (FEET) ①	Q	HEADWATER COMPUTATION: INLET CONTROL $\frac{HW}{D}$	INLET CONTROL HW	OUTLET CONTROL HW=H+h_o-LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW ②	h_o ③	LS_o	HW	EXHIBIT $\frac{HW}{D}$	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
K_e Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	①								②	③						
10'Ø set approximately 1' below the existing stream bed																							
Equivalent 9.5' Ø pipe																							
				X				9.5	105	0.3	2.9	0.7	0.2	2.5	6.0	2.0	6.0	2.0	4.2	0.4	4.2	6.5	Barrel velocity
				X				9.5	345	0.7	6.7	0.7	1.1	4.5	7.0	3.6	7.0	2.0	6.1	0.6	6.7	9.0	Barrel velocity

SUMMARY AND RECOMMENDATIONS

Q2 = 105 cfs Vb = 6.5 fps @ db = 2.7 ft. (n = 0.040) culvert barrel
Q50 = 345 cfs Vb = 9.0 fps @ db = 4.8 ft. (n = 0.040) culvert barrel

① USE CULVERT DIAMETER FOR ROUND PIPE. USE RISE DIMENSION FOR ARCH CULVERTS.
② TW=0 IS NORMAL DEPTH UNLESS OTHERWISE NOTED.
③ h_o IS THE DISTANCE BETWEEN $\frac{d_c+D}{2}$ AND TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

PROJECT NAME: 12-D
NUMBER

STREAM NAME: Ruby Creek
DRAINAGE AREA: 5.5 SQUARE MILES

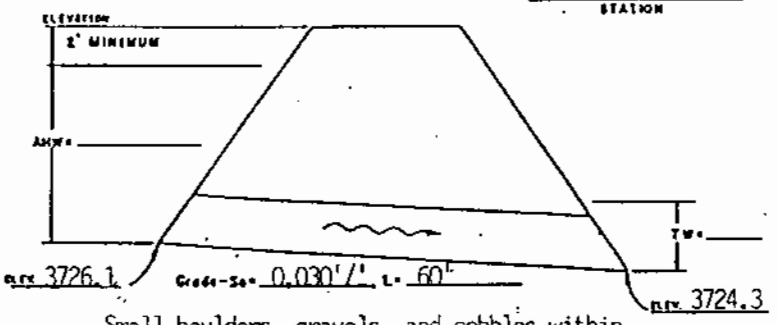
MAP: USGS Quad - "Bates, Oregon"

LOCATION: SECTION 6 TOWNSHIP 11S RANGE 34E MERIDIAN

DESIGNER: Browning
DATE: 11/10/88
CHECKED BY
DATE

Q_2 = 40 cfs TW_2 = 1.0'

Q_{50} = 165 cfs TW_{50} = 2.1'



REMARKS: Small boulders, gravels, and cobbles within the culvert barrel.

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE ENDS PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	METAL PIPE: STRUCTURAL PLATE (CORNERS)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	HEADWALLS: END SECTION	SIZE D FEET ①	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL HW=H+h_o-LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW ①	h_o ①	LS_o	HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
K_e Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	①															
8' X 4'				X				4	40	0.4	1.6	0.7	0.5	0.8	2.4	1.0	2.4	1.8	1.1	0.2	1.6	5.9	Barrel velocity
8' X 4'				X				4	165	1.1	4.4	0.7	3.0	2.4	3.2	2.1	3.2	1.8	4.4	1.1	4.4	8.5	Barrel velocity

SUMMARY AND RECOMMENDATIONS

Q2 = 40 cfs Vb = 5.9 fps @ db = 1.2 ft. (n = 0.04) culvert barrel
Q50 = 165 cfs Vb = 8.5 fps @ db = 2.7 ft. (n = 0.04) culvert barrel

① USE CULVERT DIAMETER FOR ROUND PIPES. USE RISE DIMENSION FOR ARCH CULVERTS. ② WHEN TW IS UNKNOWN, LEAVE COLUMN BLANK. ③ h_o IS THE GREATER OF $\frac{d_c+D}{2}$ OR TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

PROJECT NAME: 12-E
NUMBER

STREAM NAME: Big Creek
DRAINAGE AREA: 30.7 SQUARE MILES

MAP: USGS Quad - "Dale, Oregon"

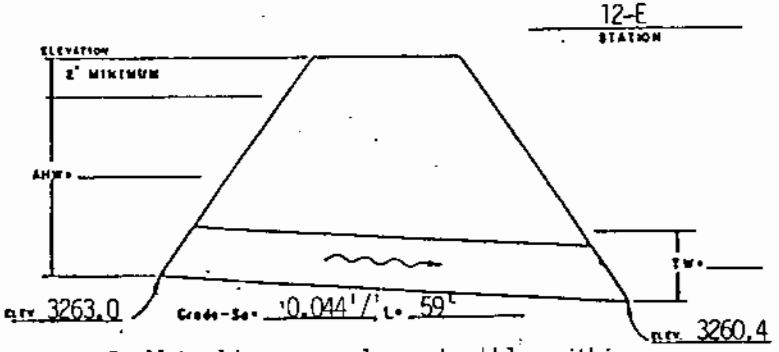
LOCATION: SECTION 21 TOWNSHIP 9S RANGE 32E WILLAMETTE MERIDIAN

DESIGNED BY:
DATE:

CHECKED BY: Browning
DATE: 11/10/88

Q_{*2} = 230 cfs TW_{*2} = 1.8'

Q_{*50} = 725 cfs TW_{*50} = 3.4'



REMARKS: Small boulders, gravels, and cobbles within the culvert barrel. Also some bedrock is exposed.

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVE-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	METAL PIPE: STRUCTURAL PLATE (CORRUGATED)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END SECTION	SIZE D (FEET)	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL K_e	OUTLET CONTROL H	OUTLET CONTROL d_c	OUTLET CONTROL $\frac{d_c+D}{2}$	OUTLET CONTROL TW	OUTLET CONTROL h_o	OUTLET CONTROL LS_o	OUTLET CONTROL HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
K_e Coefficient	0.2	0.9	0.7	0.7	0.5	0.7	0.5																
12' X 7'				X				7	230	0.6	4.2	0.7	0.8	2.1	4.6	1.8	4.6	2.6	2.8	0.4	4.2	10.8	Barrel velocity
12' X 7'				X				7	725	1.5	10.5	0.7	6.7	4.9	6.0	3.4	6.0	2.6	10.1	1.4	10.5	14.7	Barrel velocity

SUMMARY AND RECOMMENDATIONS

Q2 = 230 cfs Vb = 10.8 fps @ db = 2.2 ft. (n = 0.040) culvert barrel

Q50 = 725 cfs Vb = 14.7 fps @ db = 4.6 ft. (n = 0.040) culvert barrel

① USE CULVERT DIAMETER FOR ROUND PIPES
USE RISE DIMENSION FOR ARCH CULVERTS

② WHEN TW IS UNKNOWN, ASSUME COMPUTED VALUE

③ h_o IS THE GREATER OF $\frac{d_c+D}{2}$ AND TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

PROJECT NAME: 12-F
NUMBER

STREAM NAME: Indian Creek
DRAINAGE AREA: 23.5 SQUARE MILES

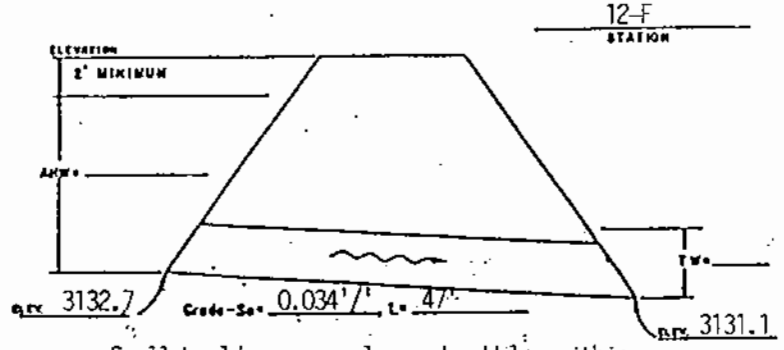
LOCATION: USGS Quad - "Dale, Oregon"
SECTION: 7 TOWNSHIP: 9S RANGE: 32E MERIDIAN

DESIGNED BY
DATE

CHECKED BY: Browning
DATE: 11/10/88

Q_2: 185 cfs TW_2: 1.6'

Q_{50}: 590 cfs TW_{50}: 2.8'



REMARKS: Small boulders, gravels, and cobbles within barrel.

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVE-END PROJECTING	METAL PIPE HEADWALLS: PROJECTING	MITERED	STRUCTURAL PLATE INTERIOR	VERTICAL	MITERED	END-SECTION	SIZE D (FEET)	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	HW	OUTLET CONTROL HW=H+h_o-LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	-HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
K_e Coefficient→	0.2	0.9	0.7	0.7	0.5	0.7	0.5																
12' X 7'				X				7	185	0.5	3.5	0.7	0.5	2.1	4.6	1.6	4.6	1.6	3.5	0.5	3.5	9.6	Barrel velocity
12' X 7'				X				7	590	1.2	8.4	0.7	4.0	4.2	5.6	2.8	5.6	1.6	8.0	1.1	8.4	13.1	Barrel velocity

SUMMARY AND RECOMMENDATIONS

Q2 = 185 cfs Vb = 9.6 fps @ db = 2.1 ft. (n = 0.040) culvert barrel
Q50 = 590 cfs Vb = 13.1 fps @ db = 4.0 ft. (n = 0.040) culvert barrel

① USE CULVERT DIAMETER FOR ROUND PIPES
USE RISE DIMENSION FOR ARCH CULVERTS

② WHEN TW IS UNKNOWN, USE CRITICAL DEPTH

③ P_o IS THE GREATER OF $\frac{d_c+D}{2}$ OR TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

PROJECT NAME: 12-G NUMBER

STREAM NAME: Granite Creek DRAINAGE AREA: 11.4 SQUARE MILES

MAP: USGS Quad - "Dale, Oregon"

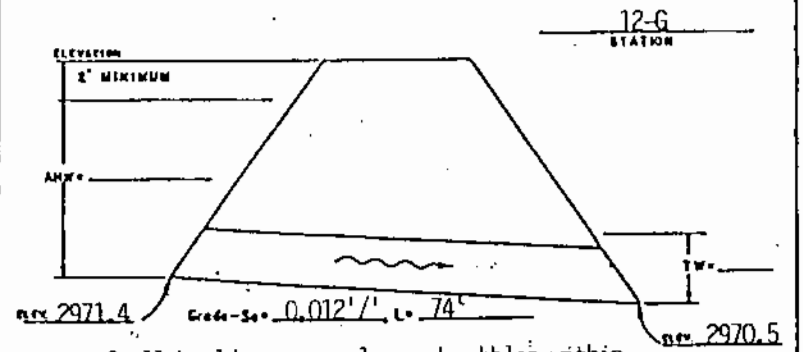
LOCATION: SECTION 17 TOWNSHIP 8S RANGE 31E MERIDIAN

DESIGNED BY: DATE:

CHECKED BY: Browning DATE: 11/10/88

Q_{-2} 75 cfs TW_{-2} 1.2'

Q_{-50} 290 cfs TW_{-50} 2.3'



REMARKS: Small boulders, gravels, and cobbles within barrel.

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVED-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	METAL PIPE: STRUCTURAL PLATE (MITERED)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END SECTION	SIZE D (FEET)	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL HW=H+h_o-LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	-HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
K_e Coefficient	0.2	0.9	0.7	0.7	0.5	0.7	0.5	①								①	①						
12.8' X 7'						X		7	75	0.4	2.8	0.7	0.2	0.7	3.9	1.2	3.9	0.9	3.2	0.5	3.2	4.9	Barrel velocity
12.8' X 7'						X		7	290	0.7	4.9	0.7	1.4	2.8	4.9	2.3	4.9	0.9	5.4	0.8	5.4	7.2	Barrel velocity

SUMMARY AND RECOMMENDATIONS

Q2 = 75 cfs Vb = 4.9 fps @ db = 1.8 ft. (n = 0.040) culvert barrel
Q50 = 290 cfs Vb = 7.2 fps @ db = 3.7 ft. (n = 0.040) culvert barrel

① USE CULVERT DIAMETER FOR ROUND PIPES. USE RISE DIMENSION FOR ARCH CULVERTS.
② INLET TO BE BEVELED. SEE CULVERT DETAILS.
③ h_o IS THE GREATER OF $\frac{d_c+D}{2}$ AND TW

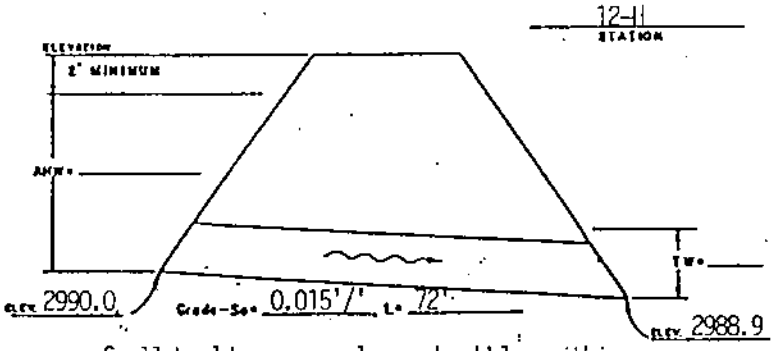
CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

PROJECT NAME: 12-H
NUMBER:
STREAM NAME: Granite Creek
DRAINAGE AREA: 11.4 SQUARE MILES
MAP: USGS Quad - "Dale, Oregon"
LOCATION: SECTION 17 TOWNSHIP 8S RANGE 31E MERIDIAN
DESIGNED:
DATE:
CHECKED BY: Browning
DATE: 11/10/88

Q_{*2} = 75 cfs TW_{*2} = 1.2'

Q_{*50} = 290 cfs TW_{*50} = 2.2'



REMARKS: Small boulders, gravels, and cobbles within the barrel.

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVE-END PROJECTING	METAL PIPE HEADWALLS: PROJECTING	MITERED	STRUCTURAL PLATE (CORNERED)	VERTICAL	MITERED	END SECTION	SIZE D (FEET)	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	HW	OUTLET CONTROL HW = K_e + H + d_c + $\frac{d_c+D}{2}$ - TW + h_o - LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
K_e Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5																
13.1' X	7.6'					X		7.6'	75	0.3	2.3	0.7	0.2	0.9	4.3	1.2	4.3	1.1	3.4	0.4	3.4	4.7	Barrel velocity
13.1' X	7.6'					X		7.6'	290	0.6	4.6	0.7	0.8	2.7	5.2	2.2	5.2	1.1	4.9	0.6	4.9	7.1	Barrel velocity

SUMMARY AND RECOMMENDATIONS

Q2 = 75 cfs Vb = 4.7 fps @ db = 1.7 ft. (n = 0.045) culvert barrel

Q50 = 290 cfs Vb = 7.1 fps @ db = 3.7 ft. (n = 0.045) culvert barrel

* USE CULVERT DIAMETER FOR ROUND PIPES. USE RISE DIMENSION FOR ARCH CULVERTS.
** WHEN TW IS UNKNOWN, ASSUME CULVERT FLOWS
*** h_o IS THE LARGER OF $\frac{d_c+D}{2}$ OR TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

PROJECT NAME: 12-I
NUMBER:

STREAM NAME: Granite Creek
DRAINAGE AREA: 14.5 SQUARE MILES

MAP: USGS Quad - "Dale, Oregon"

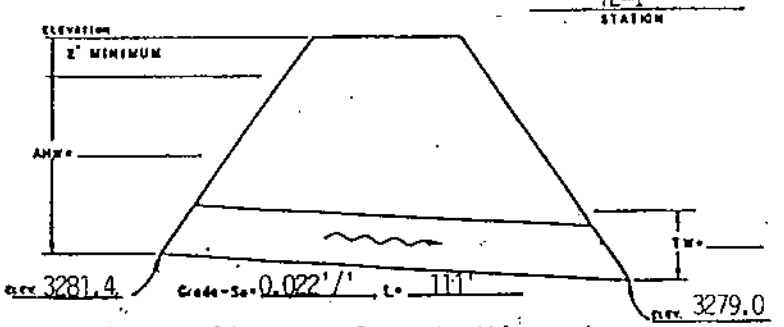
LOCATION: SECTION 30 TOWNSHIP 8S RANGE 30E MERIDIAN

DESIGNED BY:
DATE:

CHECKED BY: Browning
DATE: 11/10/88

Q_{*2} 95 cfs TW_{*2} 2.2'

Q_{*50} 350 cfs TW_{*50} 4.2'



REMARKS: Small boulders, gravels, and cobbles within the barrel.

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVE-END PROJECTING	METAL PIPE HEADWALLS: PROJECTING	MITERED	STRUCTURAL PLATE (INTERIOR)	VERTICAL	MITERED	END SECTION	SIZE D (FEET)	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	HW	OUTLET CONTROL HW=H+h_o-LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
K_e Coefficient→	0.2	0.9	0.7	0.7	0.5	0.7	0.5	①								①	①						
13.2' X	11'					X		11	95	0.2	2.2	0.7	0.1	1.0	6.0	2.2	6.0	2.4	3.7	0.3	3.7	6.2	Barrel velocity
13.2' X	11'					X		11	350	0.5	5.5	0.7	0.6	4.0	7.5	4.2	7.5	2.4	5.7	0.5	5.7	9.0	Barrel velocity

SUMMARY AND RECOMMENDATIONS

Q2 = 95 cfs Vb = 6.2 fps @ db = 2.4 ft. (n = 0.045) culvert barrel

Q50 = 350 cfs Vb = 9.0 fps @ db = 4.6 ft. (n = 0.045) culvert barrel

① USE CULVERT DIAMETER FOR ROUND PIPE. USE RISE DIMENSION FOR ARCH CULVERTS. ② SLOPE TY IS MANNING, SCAME CHANNEL SLOPE. ③ h_o IS THE GREATER OF $\frac{d_c+D}{2}$ OR TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

PROJECT NAME: 12-J
NUMBER

STREAM NAME: Sunflower Creek
DRAINAGE AREA: 22.6 SQUARE MILES

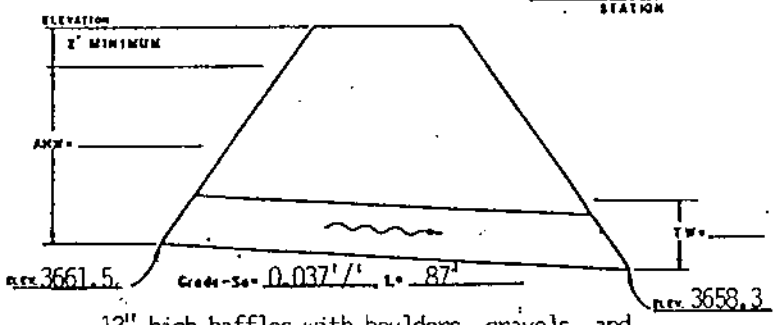
MAP: USGS Quad - "Dayville, Oregon"

LOCATION: 19 SECTION, 16S TOWNSHIP, 27E RANGE, MERIDIAN

DESIGNER: Browning
DATE: 11/10/88
CHECKED BY
DATE

Q_{*2} 135 cfs TW_{*2} 1.1'

Q_{*50} 485 cfs TW_{*50} 2.1'



REMARKS: 12" high baffles with boulders, gravels, and cobbles within the barrel.

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVE-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	STRUCTURAL PLATE (MITERED)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END-SECTION	SIZE D (FEET)	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL HW=H+h_o-LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW @	h_o @	LS_o	HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
Ke Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	@															
17.3' Span X 10' rise with 12" high baffle																								
Equivalent 17.3' X 9'																								
						X		9	135	0.3	2.7	0.7	0.2	1.6	5.3	1.1	5.3	3.2	2.3	0.3	2.7	7.0	Barrel velocity
						X		9	485	0.6	5.4	0.7	1.0	3.2	6.1	2.1	6.1	3.2	3.9	0.4	5.4	10.8	Barrel velocity

SUMMARY AND RECOMMENDATIONS

Q2 = 135 cfs Vb = 7.0 fps @ db = 1.7 ft. (n = 0.045) culvert barrel
Q50 = 485 cfs Vb =10.8 fps @ db = 3.4 ft. (n = 0.045) culvert barrel

① USE CULVERT DIRECTLY FOR ROUND PIPES
USE RISE DIMENSION FOR ARCH CULVERTS

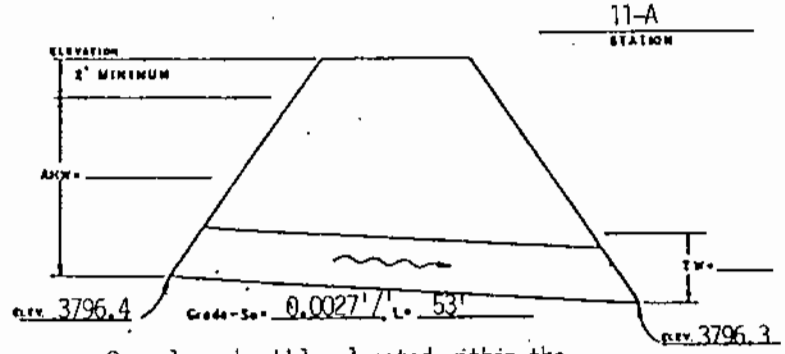
② WHEN TW IS UNKNOWN, SOME CULVERT DESIGNERS ASSUME TW = D/2 OR D

③ h_o IS USE CREATED BY $\frac{d_c+D}{2}$ OR TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

PROJECT NAME	11-A
STREAM NAME	Marks Creek
DRAINAGE AREA	29.1 SQUARE MILES
MAP	USGS Quad - "Lookout Mountain"
LOCATION	SECTION 17 TOWNSHIP 13S RANGE 19E MERIDIAN
DESIGNER	Browning
DATE	11/10/88
CHECKED BY	
DATE	
Q_{*2}	115 cfs
TW_{*2}	1.7'
Q_{*50}	600 cfs
TW_{*50}	3.7'



REMARKS: Gravels and cobbles located within the culvert barrel.

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVE-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	STRUCTURAL PLATE (INTERIOR)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END SECTION	SIZE D (FEET) ①	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL HW=H+h_o-LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW ①	h_o ①	LS_o	HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
K_e Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	①															
18' X 8.8'				X				8.8	115	0.2	1.8	0.7	0.1	0.9	4.9	1.7	4.9	0.1	4.9	0.6	4.9	3.0	Barrel Velocity
18' X 8.8'				X				8.8	600	0.7	6.2	0.7	1.0	3.5	6.2	3.7	6.2	0.1	7.1	0.8	7.1	4.8	Barrel Velocity

SUMMARY AND RECOMMENDATIONS

For Q2 = 115 cfs Vb = 3.0 fps @ db = 2.6 ft. (n = 0.040) for the culvert barrel.
For Q50 = 600 cfs Vb = 4.8 fps @ db = 8.8 ft. (n = 0.040) for the culvert barrel.

① USE CULVERT DIAMETER FOR ROUND PIPES - USE RISE DIMENSION FOR ARCH CULVERTS ② WHEN TW IS UNKNOWN, LEAVE COLUMN BLANK ③ h_o IS THE GREATER OF $\frac{d_c+D}{2}$ OR TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

10-A
PROJECT NAME / NUMBER

Brown's Creek 24.7
STREAM NAME / DRAINAGE AREA (SQUARE MILES)

USGS Quad -
MAP

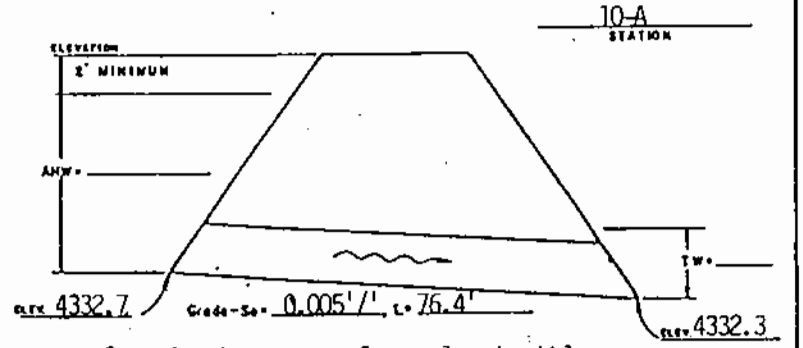
29 21S 8E
LOCATION / SECTION / TOWNSHIP / RANGE / MERIDIAN

DESIGNED / DATE

Browning 11/10/88
CHECKED BY / DATE

Q_2 100 cfs TW_2 1.8'

Q_{50} 415 cfs TW_{50} 3.6'



REMARKS: Sporadic deposition of gravel and cobbles within the culvert barrel.

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVE-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	METAL PIPE: STRUCTURAL PLATE (CORNER)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END SECTION	SIZE D (FEET)	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL HW=H+h_o-LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
K_e Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	①								①	①						
12.6' X 9.4' set approximately 1.5' below the stream bed.																							
Use equivalent 12.6' X 8.0'.																							
						X		8	100	0.3	2.4	.7	0.2	1.6	4.8	1.8	4.8	0.4	4.6	0.6	4.6	4.2	Barrel Velocity
						X		8	415	0.8	6.4	.7	1.4	3.5	5.7	3.6	5.7	0.4	6.7	0.8	6.7	6.1	Barrel Velocity

SUMMARY AND RECOMMENDATIONS

For Q2 = 100 cfs Vb = 4.2 fps @ db = 2.4 ft. (n = 0.035) for the culvert barrel.
For Q50 = 415 cfs Vb = 6.1 fps @ db = 6.4 ft. (n = 0.035) for the culvert barrel.

① USE CULVERT DIAMETER FOR ROUND PIPES. USE RISE DIMENSION FOR ARCH CULVERTS.
② REFER TO US HALFORD, LEMOS COLORS BOOK.
③ h_o IS THE GREATER OF $\frac{d_c+D}{2}$ OR TW.

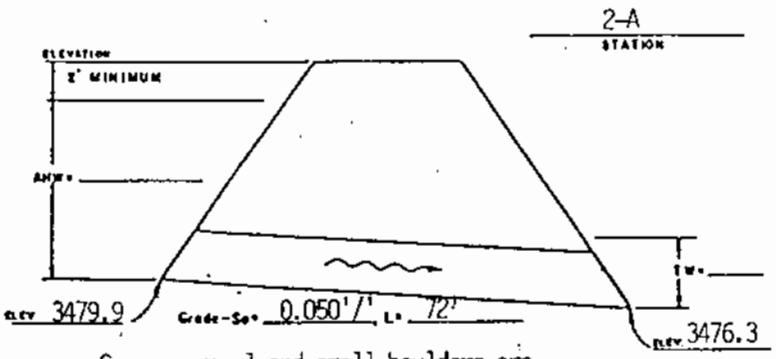
CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

PROJECT NAME: 2-A
NUMBER:
STREAM NAME: Lowe Creek
DRAINAGE AREA: 6.8 SQUARE MILES
MAP: USGS Quad - "Breitenbush Hot Springs, Oregon"
LOCATION: SECTION 24 TOWNSHIP 7S RANGE 7E MERIDIAN
DESIGNED BY: Browning
DATE: 11/10/88
CHECKED BY:
DATE:

Q_{*2} 440 cfs TW_{*2} 2.6'

Q_{*50} 1160 cfs TW_{*50} 3.9'



REMARKS: Coarse gravel and small boulders are located throughout the barrel.

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVED-END PROJECTING	METAL PIPE HEADWALLS: PROJECTING	MITERED	STRUCTURAL PLATE (INTERIOR)	VERTICAL	MITERED	END-SECTION	SIZE D (FEET) ①	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	HW	OUTLET CONTROL HW = H + h_o - LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW ①	h_o ①	LS_o	HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
Ke Coefficient→	0.2	0.9	0.7	0.7	0.5	0.7	0.5																
21.5' span X 11.7' rise arch with concrete footings (approximately 1' of vertical exposure).																							
			X					11.7	440	0.4	4.7	0.7	0.2	2.3	7.0	2.6	7.0	3.6	3.6	0.3	4.7	10.5	Barrel Velocity
			X					11.7	1160	0.7	8.2	0.7	0.8	4.7	8.2	3.9	8.2	3.6	5.4	0.5	8.2	14.7	Barrel Velocity

SUMMARY AND RECOMMENDATIONS

For Q2 = 440 cfs Vb = 10.5 fps @ db = 2.1 ft. (n = 0.045) for the culvert barrel.

For Q50 = 1160 cfs Vb = 14.7 fps @ db = 3.6 ft. (n = 0.045) for the culvert barrel.

① USE CULVERT DIAMETER FOR ROUND PIPES
USE RISE DIMENSION FOR ARCH CULVERTS

* WHEN TW IS UNKNOWN, LEAVE COLUMN BLANK

② h_o IS THE GREATER OF $\frac{d_c+D}{2}$ OR TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

PROJECT NAME: 2-B
NUMBER

STREAM NAME: Poop Creek
DRAINAGE AREA: 1.75 SQUARE MILES

MAP: USGS Quad - "Breitenbush Hot Springs, Oregon"

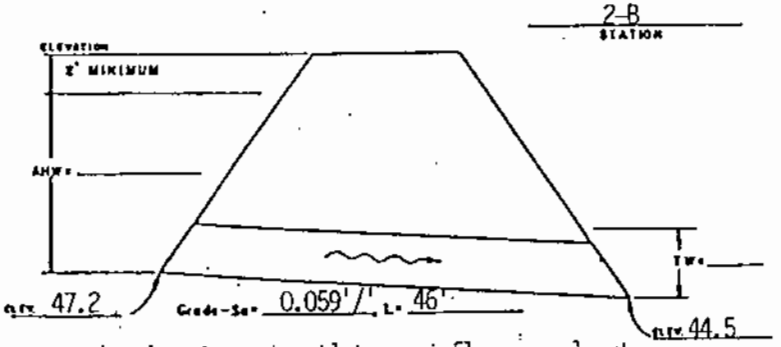
LOCATION: 9 SECTION, 7S TOWNSHIP, 8E RANGE, MERIDIAN

DESIGNED BY: Browning
DATE: 11/10/88

CHECKED BY
DATE

Q_{-2} = 10 cfs TW_{-2} = 0.4'

Q_{-50} = 35 cfs TW_{-50} = 1.4'



REMARKS: Log barriers at outlet may influence culvert flow conditions during large runoff events.

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVE-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	STRUCTURAL PLATE (CORNER)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END SECTION	SIZE D (FEET)	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL HW=H+h$_o$-LS$_o$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS$_o$	HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
K_e Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	①								②	②						
48" CMP			X					4	10	0.4	1.6	0.7	0.1	1.0	2.5	0.4	2.5	2.7	0.0	0	1.6	8.0	Barrel Velocity
48" CMP			X					4	35	0.6	2.4	0.7	0.4	1.8	2.9	1.4	2.9	2.7	0.6	2.4	2.4	11.5	Barrel Velocity

SUMMARY AND RECOMMENDATIONS

For Q2 = 10 cfs Vb = 8 fps @ db = .65 ft. (n = 0.024) for the culvert barrel.
For Q50 = 35 cfs Vb = 11.5 fps @ db = 1.2 ft. (n = 0.024) for the culvert barrel.

The Q2 and Q50 discharges are based upon USGS gaging data at the site.

① USE CHOSEN DIAMETER FOR ROUND PIPES. USE RISE DIMENSION FOR ARCH CULVERTS.
② WHEN TW IS UNKNOWN, LEAVE COLUMN BLANK.
③ h_o IS THE LARGER OF $\frac{d_c+D}{2}$ OR TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

3-A (PROJECT NAME / NUMBER)

Pine Creek (STREAM NAME) 4.0 (DRAINAGE AREA) SQUARE MILES

USGS Quad - "Fernwood, Oregon" (MAP)

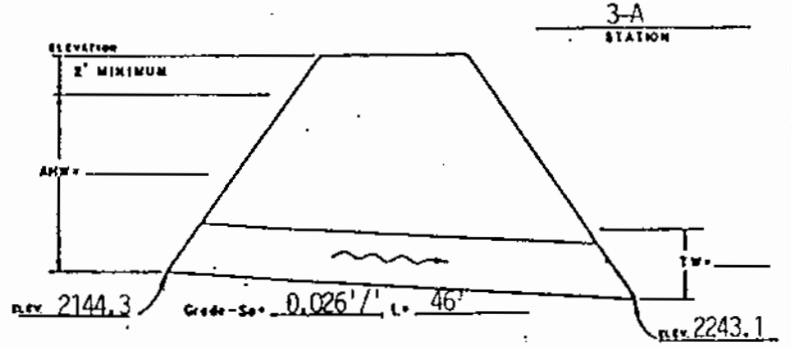
27 (SECTION) 6S (TOWNSHIP) 3E (RANGE) (MERIDIAN) (LOCATION)

Browning (DESIGNER) 11/10/88 (DATE)

(CHECKED BY) (DATE)

Q_2 250 cfs TW_2 1.7'

Q_{50} 665 cfs TW_{50} 2.8'



REMARKS:

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVE-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	METAL PIPE: STRUCTURAL PLATE (CORRUGATED)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END SECTION	SIZE D (FEET) ①	Q
K_e Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	①	
7.5' Ø		X						7.5	250
7.5' Ø		X						7.5	665

HEADWATER COMPUTATION: INLET CONTROL $\frac{HW}{D}$	INLET CONTROL HW	OUTLET CONTROL HW = H + h_o - LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW ①	h_o ①	LS_o	HW	OUTLET $\frac{HW}{D}$	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
0.75	5.6	0.9	0.7	3.8	5.6	1.8	5.6	1.2	5.1	0.7	5.6	13.7	Barrel Velocity
1.5	11.3	0.9	5.0	6.2	6.8	2.8	6.8	1.2	10.6	1.4	11.3	17.1	Barrel Velocity

SUMMARY AND RECOMMENDATIONS

For Q2 = 230 cfs Vb = 13.7 fps @ db = 3.0 ft. (n = 0.024) for the culvert barrel.

For Q50 = 580 cfs Vb = 17.1 fps @ db = 5.3 ft. (n = 0.024) for the culvert barrel.

The 36" Ø flood relief pipe carries approximately 20 cfs and 85 cfs for the Q2 and Q50 respectively.

① USE CHECKED DIAMETER FOR ROUND PIPES. USE RISE DIMENSION FOR ARCH CULVERTS.

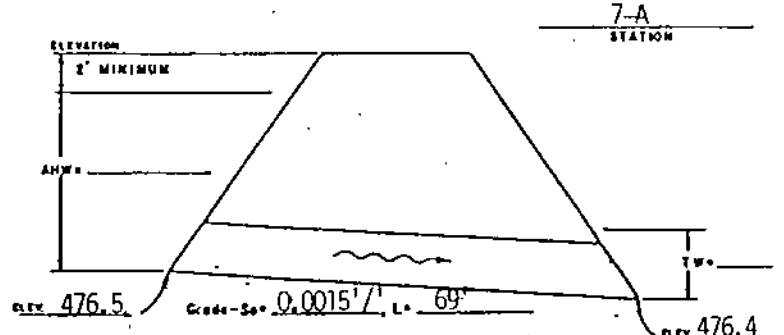
② WHEN TW IS UNKNOWN, LEAVE COLUMN BLANK.

③ h_o IS THE GREATER OF $\frac{d_c+D}{2}$ AND TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

PROJECT NAME: 7-A
NUMBER:
STREAM NAME: Haight Creek
DRAINAGE AREA: 4.0 SQUARE MILES
MAP: USGS Quad - "High Point, Oregon"
LOCATION: SECTION 34 TOWNSHIP 9S RANGE 7W MERIDIAN
DESIGNED BY: Browning
DATE: 11/10/88
CHECKED BY:
DATE:
Q_{*2} = 190 cfs TW_{*2} = 2.1'
Q_{*50} = 440 cfs TW_{*50} = 3.1'



REMARKS: Small gravel and sandstone bed are located within the barrel.

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE BEVELED-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	STRUCTURAL PLATE (MITERED)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END-SECTION	SIZE D (FEET)	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL K_e	OUTLET CONTROL H	OUTLET CONTROL d_c	OUTLET CONTROL $\frac{d_c+D}{2}$	OUTLET CONTROL TW*	OUTLET CONTROL h_o*	OUTLET CONTROL LS_o	OUTLET CONTROL HW	OUTLET CONTROL HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
Ke Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	*															
18.2' X 8.9'				X				8.9	190	0.4	4.5	0.7	0.2	1.7	5.3	2.1	5.3	0.1	5.4	0.6	5.4	3.1	Barrel Velocity
18.2' X 8.9'				X				8.9	440	0.6	5.3	0.7	0.5	2.6	5.7	3.1	5.7	0.1	6.1	0.7	6.1	3.7	Barrel Velocity

SUMMARY AND RECOMMENDATIONS

For Q2 = 190 cfs Vb = 3.1 fps @ db = 3.8 ft. (n = 0.035) for the culvert barrel.
For Q50 = 440 cfs Vb = 3.7 fps @ db = 8.0 ft. (n = 0.035) for the culvert barrel.

NOTE: The above does not consider the influence of the Suislaw River located d/s from the culvert outlet. Based upon the field survey the river probably controls the hydraulic characteristics at the culvert site during high flows.

* USE CHOSEN DIAMETER FOR ROUND PIPES
USE RISE DIMENSION FOR ARCH CULVERTS

** SLOPE TO BE ASSUMED, USUALLY CULVERT SLOPE

*** h_o IS THE LARGER OF $\frac{d_c+D}{2}$ OR TW

CULVERT DESIGN SHEET

US DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION TEN VANCOUVER, WASHINGTON

PROJECT NAME: 7-B
NUMBER: 7-B

STREAM NAME: Eames Creek
DRAINAGE AREA: 5.2 SQUARE MILES

MAP: USGS Quad - "High Point, Oregon"

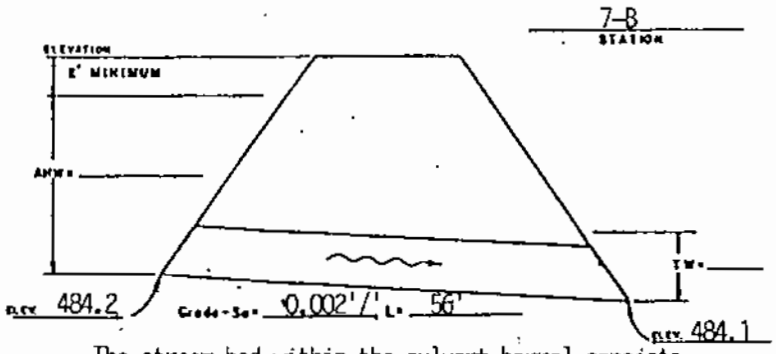
LOCATION: SECTION 7, TOWNSHIP 19S, RANGE 6W, WILLAMETTE MERIDIAN

DESIGNED BY: Browning
DATE: 11/10/88

CHECKED BY:
DATE:

Q_2 = 280 cfs TW_2 = 3.3'

Q_{50} = 640 cfs TW_{50} = 5.0'



REMARKS: The stream bed within the culvert barrel consists of sandstone bedrock.

SIZE (INCHES)	CULVERT DESCRIPTION: CONCRETE GROOVE-END PROJECTING	METAL PIPE: PROJECTING	METAL PIPE: MITERED	STRUCTURAL PLATE (BOTTOMED)	HEADWALLS: VERTICAL	HEADWALLS: MITERED	END-SECTION	SIZE D (FEET)	Q	HEADWATER COMPUTATION: INLET CONTROL HW/D	INLET CONTROL HW	OUTLET CONTROL HW = H + h_o - LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW ①	h_o ①	LS_o	-HW	OUTLET HW/D	CONTROLLING HW	OUTLET VELOCITY	COMMENTS
K_e Coefficient →	0.2	0.9	0.7	0.7	0.5	0.7	0.5	①															
13.8' X 6.9' with approximately 1.0' of concrete footing exposed.																								
13.8' X 8'				X				8	280	0.5	4.0	0.7	0.6	2.4	5.2	3.3	5.2	0.1	5.7	0.7	5.7	4.0	Barrel Velocity
13.8' X 8'				X				8	640	1.0	8.0	0.7	2.5	4.5	6.2	5.0	6.2	0.1	8.6	1.1	8.6	7.4	Barrel Velocity

SUMMARY AND RECOMMENDATIONS

For Q2 = 280 cfs Vb = 4.0 fps @ db = 5.6 ft. (n = 0.035) for the culvert barrel.

For Q50 = 640 cfs Vb = 7.4 fps @ db = 8.0 ft. (n = 0.035) for the culvert barrel.

① USE CULVERT DIAMETER FOR ROUND PIPES. USE RISE DIMENSION FOR ARCH CULVERTS

② WHEN TW IS UNKNOWN, LEAVE COLUMN BLANK

③ h_o IS THE GREATER OF $\frac{d_c+D}{2}$ OR TW

APPENDIX F

STREAM BED MATERIAL GRADATION DATA

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0035

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY: BRYANT/HOWARD
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION:
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: MT. SCOTT CR CULVERT
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
5"	100.0
4"	94.7
3"	94.7
2"	90.4
1 1/2"	84.8
1"	69.0
3/4"	59.1
1/2"	43.8
3/8"	35.4
#4	22.1
#10	12.2
#40	2.5
#100	1.3
#200	1.0

RAYMOND E. ROSENBAUM
CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON
MATERIALS ENGINEER

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0034

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY: BRYANT/HOWARD
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION:
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: NEWELL CREEK
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
3"	100.0
2"	94.8
1 1/2"	94.8
1"	91.2
3/4"	87.8
1/2"	80.0
3/8"	72.3
#4	55.5
#10	41.5
#40	15.2
#100	3.7
#200	1.7

RAYMOND E. ROSENBAUM
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FOR EMORY S. RICHARDSON
MATERIALS ENGINEER

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0007

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: COOL CREEK CULVERT
INTENDED USE:
QUANTITY REPRESENTED:

SAMPLED BY:
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION:
COUNTY: STATE: OR
REMARKS:

OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
6"	100.0
5"	89.7
4"	85.7
3"	64.4
2"	51.5
1 1/2"	47.7
1"	41.9
3/4"	36.5
1/2"	27.5
3/8"	22.3
#4	11.8
#10	5.4
#40	1.3
#100	0.5
#200	0.3

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FOR EMORY S. RICHARDSON
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DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0005

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY:
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION:
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: LOST CREEK CULVERT
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
4"	100.0
3"	93.6
2"	83.8
1 1/2"	76.9
1"	60.6
3/4"	54.0
1/2"	46.5
3/8"	42.9
#4	35.6
#10	27.0
#40	4.8
#100	0.8
#200	0.3

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CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON
MATERIALS ENGINEER

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0008

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY:
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION:
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: POLALLIE CREEK
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
7"	100.0
6"	77.3
4"	64.1
3"	54.6
2"	40.8
1 1/2"	31.0
1"	25.3
3/4"	22.1
1/2"	18.1
3/8"	15.9
#4	12.4
#10	9.3
#40	4.3
#100	1.2
#200	0.4

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FOR EMORY S. RICHARDSON
MATERIALS ENGINEER

PAGE 1 OF 1 PAGES (AG88-01-0008)

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0020

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY:
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION:
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: MOFFET CREEK
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
5"	100.0
4"	90.6
3"	79.0
2"	51.5
1 1/2"	39.9
1"	27.5
3/4"	22.7
1/2"	17.1
3/8"	14.5
#4	9.4
#10	5.4
#40	1.7
#100	0.9
#200	0.6

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CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON
MATERIALS ENGINEER

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0019

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY:
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION:
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: LITTLE LOOKINGGLASS
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
5"	100.0
4"	91.6
3"	80.9
2"	69.4
1 1/2"	63.8
1"	49.0
3/4"	41.0
1/2"	31.0
3/8"	26.3
#4	17.2
#10	9.4
#40	1.8
#100	0.9
#200	0.6

RAYMOND E. ROSENBAUM
CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON
MATERIALS ENGINEER

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0033

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY: BRYANT/HOWARD
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION:
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: TAMARACK GULCH
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
4"	100.0
3"	93.2
2"	86.5
1 1/2"	77.6
1"	65.8
3/4"	60.5
1/2"	55.5
3/8"	53.9
#4	50.3
#10	28.8
#40	13.9
#100	9.4
#200	5.0

RAYMOND E. ROSENBAUM
CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON
MATERIALS ENGINEER

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0004

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: S. F. CHESNIMUS CREEK
INTENDED USE:
QUANTITY REPRESENTED:

SAMPLED BY:
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION:
COUNTY: STATE: OR
REMARKS:

OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
5"	100.0
4"	86.8
3"	86.8
2"	82.9
1 1/2"	74.4
1"	62.9
3/4"	56.2
1/2"	45.9
3/8"	39.7
#4	30.0
#10	18.9
#40	6.3
#100	3.0
#200	1.6

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CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON
MATERIALS ENGINEER

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0002

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY:
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION:
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: DEVILS RUN CREEK
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
4"	100.0
3"	95.6
2"	72.2
1 1/2"	58.8
1"	44.9
3/4"	37.6
1/2"	29.8
3/8"	25.9
#4	19.3
#10	11.5
#40	1.8
#100	0.8
#200	0.4

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PAGE 1 OF 1 PAGES (AG88-01-0002)

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0012

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: BILLY CREEK
INTENDED USE:
QUANTITY REPRESENTED:

SAMPLED BY:
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION:
COUNTY: STATE: OR
REMARKS:

OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
4"	100.0
3"	90.4
2"	74.6
1 1/2"	66.0
1"	53.8
3/4"	46.8
1/2"	37.8
3/8"	33.3
#4	24.8
#10	15.2
#40	2.5
#100	1.1
#200	0.7

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PAGE 1 OF 1 PAGES (AG88-01-0012)

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0006

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY:
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION:
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: CAMP CREEK
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
5"	100.0
4"	89.6
3"	83.4
2"	76.9
1 1/2"	72.1
1"	60.1
3/4"	51.4
1/2"	40.2
3/8"	34.8
#4	25.8
#10	18.1
#40	1.6
#100	0.1
#200	0.1

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DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0017

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:

SAMPLED BY:
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION:
COUNTY: STATE: OR
REMARKS:

SAMPLE NO.: DOE CREEK
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
5"	100.0
4"	94.4
3"	83.4
2"	70.5
1 1/2"	62.5
1"	47.8
3/4"	40.7
1/2"	33.9
3/8"	31.1
#4	25.6
#10	17.0
#40	2.2
#100	1.0
#200	0.6

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WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0014

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY:
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION: SITE D7
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: GUMBOOT CREEK
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
6"	100.0
5"	79.1
4"	72.1
3"	65.9
2"	41.5
1 1/2"	34.1
1"	25.5
3/4"	21.6
1/2"	15.6
3/8"	12.9
#4	7.9
#10	3.1
#40	0.3
#100	0.1
#200	0.1

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FEDERAL HIGHWAY ADMINISTRATION
WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0037

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY: BRYANT/HOWARD
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION:
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: ELK CREEK
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
5"	100.0
4"	83.3
3"	76.0
2"	48.1
1 1/2"	37.0
1"	28.9
3/4"	20.7
1/2"	12.4
3/8"	9.3
#4	5.1
#10	2.5
#40	1.0
#100	0.6
#200	0.3

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WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0003

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:

SAMPLED BY:
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION:
COUNTY: STATE: OR
REMARKS:

SAMPLE NO.: CHESNIMUS CREEK
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
4"	100.0
3"	84.5
2"	68.8
1 1/2"	57.1
1"	46.2
3/4"	41.3
1/2"	34.2
3/8"	31.0
#4	23.6
#10	11.1
#40	2.6
#100	1.4
#200	0.9

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DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0018

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:

SAMPLED BY: SAMPLE NO.: CROW CREEK
NO. SACKS: DEPTH: INTENDED USE:
SOURCE NO.: - - QUANTITY REPRESENTED:
SOURCE NAME:
LOCATION: 0+11 11.5RT OWNER:
COUNTY: STATE: OR TYPE OF DEPOSIT:
REMARKS:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
5"	100.0
4"	87.8
3"	87.8
2"	75.1
1 1/2"	71.2
1"	67.7
3/4"	62.4
1/2"	51.9
3/8"	43.5
#4	24.5
#10	11.5
#40	3.1
#100	1.4
#200	0.8

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WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0009

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY:
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION: SITE 1
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: MEACHAM CREEK NO. 1
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
4"	100.0
3"	97.2
2"	86.4
1 1/2"	79.8
1"	60.3
3/4"	48.2
1/2"	36.9
3/8"	32.0
#4	23.3
#10	15.0
#40	4.7
#100	2.5
#200	1.4

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DEPARTMENT OF TRANSPORTATION
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WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0010

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY:
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION: SITE 5
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: MEACHAM CREEK NO. 6
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
4"	100.0
3"	95.4
2"	84.9
1 1/2"	76.4
1"	54.4
3/4"	46.1
1/2"	35.9
3/8"	31.4
#4	23.9
#10	15.3
#40	3.9
#100	1.6
#200	0.9

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MATERIALS ENGINEER

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0036

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY: BRYANT/HOWARD
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION: SITE 6
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: MEACHAM CREEK NO. 7
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
5"	100.0
4"	92.4
3"	88.7
2"	70.1
1 1/2"	53.5
1"	29.2
3/4"	15.3
1/2"	7.2
3/8"	5.2
#4	3.3
#10	2.5
#40	1.2
#100	0.7
#200	0.4

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FOR EMORY S. RICHARDSON
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PAGE 1 OF 1 PAGES (AG88-01-0036)

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0011

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY:
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION: SITE 8
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: SHEEP CREEK
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
7"	100.0
6"	72.5
4"	72.5
3"	57.2
2"	33.6
1 1/2"	23.8
1"	16.9
3/4"	14.6
1/2"	11.2
3/8"	9.8
#4	6.6
#10	3.3
#40	0.9
#100	0.5
#200	0.3

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MATERIALS ENGINEER

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0022

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:

SAMPLED BY:
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION: WICKIUP CAMPGROUND
COUNTY: STATE: OR
REMARKS:

SAMPLE NO.: CANYON CREEK NO.1
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
4"	100.0
3"	89.7
2"	72.7
1 1/2"	67.9
1"	56.5
3/4"	49.5
1/2"	40.4
3/8"	36.0
#4	26.2
#10	16.2
#40	3.3
#100	0.9
#200	0.5

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DEPARTMENT OF TRANSPORTATION
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WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0024

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY: BRYANT/HOWARD
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION:
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: MIDDLE FK. CANYON CR
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
5"	100.0
4"	96.1
3"	96.1
2"	93.6
1 1/2"	85.8
1"	73.2
3/4"	63.7
1/2"	52.0
3/8"	45.2
#4	31.7
#10	18.6
#40	3.4
#100	1.1
#200	0.6

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DEPARTMENT OF TRANSPORTATION
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WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0023

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: CANYON CREEK NO 3

SAMPLED BY:
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION: SITE 3
COUNTY: STATE: OR
REMARKS:

INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
4"	100.0
3"	87.9
2"	68.0
1 1/2"	62.3
1"	50.5
3/4"	44.9
1/2"	37.4
3/8"	33.0
#4	23.7
#10	17.1
#40	4.1
#100	1.0
#200	0.4

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FOR EMORY S. RICHARDSON
MATERIALS ENGINEER

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0016

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:

SAMPLED BY:
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION:
COUNTY: STATE: OR
REMARKS:

SAMPLE NO.: RUBY CREEK
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
4"	100.0
3"	93.7
2"	85.8
1 1/2"	78.0
1"	64.7
3/4"	57.4
1/2"	48.2
3/8"	42.5
#4	31.2
#10	20.2
#40	5.0
#100	1.6
#200	0.8

RAYMOND E. ROSENBAUM
CHIEF MATERIALS LABORATORY

FOR EMORY S. RICHARDSON
MATERIALS ENGINEER

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0029

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY: BRYANT/HOWARD
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION:
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: BIG CREEK
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
7"	100.0
6"	86.5
5"	86.5
4"	76.4
3"	56.9
2"	48.5
1 1/2"	42.5
1"	33.9
3/4"	28.9
1/2"	24.0
3/8"	21.4
#4	15.5
#10	10.9
#40	3.6
#100	0.9
#200	0.4

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PAGE 1 OF 1 PAGES (AG88-01-0029)

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0015

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY:
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION:
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: INDIAN CREEK
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
4"	100.0
3"	91.7
2"	61.0
1 1/2"	44.3
1"	33.5
3/4"	28.4
1/2"	21.0
3/8"	17.9
#4	11.8
#10	7.4
#40	2.7
#100	1.1
#200	0.6

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PAGE 1 OF 1 PAGES (AG88-01-0015)

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0028

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY: BRYANT/HOWARD
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION: SITE 1
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: GRANITE NO. 1
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
7"	100.0
6"	89.7
5"	89.7
4"	79.5
3"	79.5
2"	65.9
1 1/2"	56.0
1"	41.4
3/4"	35.0
1/2"	27.0
3/8"	22.8
#4	15.7
#10	8.5
#40	1.6
#100	0.7
#200	0.4

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DEPARTMENT OF TRANSPORTATION
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WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0027

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY: BRYANT/HOWARD
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION: SITE 2
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: GRANITE NO. 2
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
7"	100.0
6"	90.5
5"	84.2
4"	60.3
3"	50.2
2"	41.6
1 1/2"	34.7
1"	28.5
3/4"	24.5
1/2"	20.5
3/8"	18.0
#4	13.9
#10	9.5
#40	2.5
#100	1.1
#200	0.6

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DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0026

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY: BRYANT/HOWARD
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION: SITE 3
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: GRANITE NO. 3
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
5"	100.0
4"	79.7
3"	68.1
2"	54.4
1 1/2"	48.3
1"	40.6
3/4"	36.2
1/2"	30.5
3/8"	28.2
#4	22.9
#10	15.0
#40	4.0
#100	1.6
#200	0.9

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FEDERAL HIGHWAY ADMINISTRATION
WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0021

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY:
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION:
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: SUNFLOWER CREEK
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
8"	100.0
7"	67.9
3"	58.3
2"	42.6
1 1/2"	32.5
1"	26.0
3/4"	23.3
1/2"	19.5
3/8"	17.5
#4	13.2
#10	8.6
#40	1.7
#100	0.4
#200	0.2

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MATERIALS ENGINEER

DEPARTMENT OF TRANSPORTATION
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WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0025

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY: BRYANT/HOWARD
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION:
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: MARKS CREEK
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
6"	100.0
5"	93.6
4"	93.6
3"	88.3
2"	82.5
1 1/2"	78.7
1"	67.3
3/4"	59.4
1/2"	45.2
3/8"	37.5
#4	23.0
#10	13.9
#40	5.0
#100	1.3
#200	0.6

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WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0001

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY:
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION:
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: BROWNS CREEK
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
3"	100.0
2"	96.1
1 1/2"	92.4
1"	76.6
3/4"	66.4
1/2"	51.1
3/8"	42.5
#4	24.6
#10	12.7
#40	3.5
#100	0.4
#200	0.2

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DEPARTMENT OF TRANSPORTATION
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WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0032

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY: BRYANT/HOWARD
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION:
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: LOWE CREEK
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
6"	100.0
5"	89.5
4"	76.3
3"	74.0
2"	60.4
1 1/2"	53.0
1"	37.2
3/4"	29.0
1/2"	20.7
3/8"	17.1
#4	12.1
#10	8.5
#40	2.7
#100	1.1
#200	0.7

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DEPARTMENT OF TRANSPORTATION
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WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0030

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY: BRYANT/HOWARD
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION:
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: POOP CREEK
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
8"	91.7
6"	82.3
3"	82.3
2"	58.0
1 1/2"	45.1
1"	32.5
3/4"	25.1
1/2"	17.2
3/8"	13.1
#4	5.5
#10	1.9
#40	0.7
#100	0.3
#200	0.1

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DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0031

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY: BRYANT/HOWARD
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION:
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: PINE CREEK
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
7"	100.0
6"	80.4
4"	68.9
3"	62.5
2"	59.0
1 1/2"	48.8
1"	33.7
3/4"	26.2
1/2"	18.9
3/8"	16.0
#4	9.7
#10	5.2
#40	1.4
#100	0.6
#200	0.3

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DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
WESTERN DIRECT FEDERAL DIVISION
MATERIALS SECTION

REPORT OF TESTING
Aug 21, 1990
LABORATORY CONTROL NUMBER
AG88-01-0038

PROJECT NAME: FISH PASSAGE STUDY
ACCT NO.: 191-17-41-51-0000-002H
SUBMITTED BY: MARK BROWNING
ADDRESS: 610 E 5TH ST
VANCOUVER WA 98661-3893
PHONE: 206-696-7767
SAMPLED BY: BRYANT/HOWARD
NO. SACKS: DEPTH:
SOURCE NO.: - -
SOURCE NAME:
LOCATION:
COUNTY: STATE: OR
REMARKS:

AGENCY: WDFD
PROJECT NUMBER:
DATE SAMPLED: 12-15-87
DATE SHIPPED: - -
DATE RECEIVED: 01-04-88
SAMPLE OF:
SAMPLE NO.: HAIGHT CREEK
INTENDED USE:
QUANTITY REPRESENTED:
OWNER:
TYPE OF DEPOSIT:

* *

SIEVE ANALYSIS
AS RECEIVED

SIEVE SIZE	PERCENT PASSING
3"	100.0
2"	94.9
1 1/2"	84.0
1"	66.9
3/4"	58.6
1/2"	47.4
3/8"	41.6
#4	31.5
#10	26.0
#40	9.2
#100	1.6
#200	0.8

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APPENDIX G

OUTLET SCOUR ANALYSES

LIST OF SYMBOLS AND DIMENSIONS

Q2	Two year flood, in cubic feet per second (cfs)
Q50	Fifty year flood, in cubic feet per second (cfs)
D50	Particle size from gradation curve such that 50 percent of the mixture is finer by weight, in feet (ft)
TW	Culvert tailwater, in feet (ft)
VO	Culvert outlet velocity, in feet per second (fps)
WO	Width of culvert outlet, in feet (ft)
A	Flow area at the culvert outlet, in square feet (ft^2), or culvert drainage area in square miles
YE	Equivalent depth at the culvert outlet, in feet (ft)
FR	Froude number
HS	Scour depth at culvert outlet, in feet (ft)

CULVERT OUTLET SCOUR

LOCATION	FLOOD FREQ	Q CFS	VO FPS	D50 FT	TW FT	WO FT	A SF	YE FT	FR	HS FT	TW/YE	HS/D50
SCOTT	2	170	11.00	0.06	1.70	10.00	15.45	2.78	1.16	4.29	0.61	71.50
SCOTT	50	260	15.00	0.06	3.00	10.00	17.33	2.94	1.54	8.02	1.02	133.68
NEWELL	2	95	4.00	0.01	1.60	14.00	23.75	3.45	0.38	-3.11	0.46	-474.53
NEWELL	50	275	6.00	0.01	2.80	14.00	45.83	4.79	0.48	-2.78	0.58	-423.10
COOL	2	145	4.60	0.17	2.50	14.00	31.52	3.97	0.41	-3.25	0.63	-19.12
COOL	50	365	6.30	0.17	5.60	14.00	57.94	5.38	0.48	-3.20	1.04	-18.82
LOST	2	255	5.80	0.06	2.50	18.20	43.97	4.69	0.47	-2.88	0.53	-48.05
LOST	50	650	8.20	0.06	4.70	18.20	79.27	6.30	0.58	-1.83	0.75	-30.45
POLLALIE	2	265	21.50	0.25	3.30	12.70	12.33	2.48	2.40	13.47	1.33	53.87
POLLALIE	50	690	29.50	0.25	4.70	12.70	23.39	3.42	2.81	22.90	1.37	91.58
MOTTET	2	125	16.40	0.17	3.00	5.67	7.62	1.95	2.07	8.54	1.54	50.23
MOTTET	50	375	20.50	0.17	4.90	5.67	18.29	3.02	2.08	13.31	1.62	78.31
L. LOOKING	2	195	6.00	0.08	2.40	17.50	32.50	4.03	0.53	-1.79	0.60	-22.39
L. LOOKING	50	560	8.00	0.08	4.60	17.50	70.00	5.92	0.58	-1.65	0.78	-20.61
TAMARACK	2	11	5.50	0.02	0.80	6.00	2.00	1.00	0.97	0.94	0.80	46.94
TAMARACK	50	55	9.60	0.02	1.40	6.00	5.73	1.69	1.30	3.34	0.83	167.03
S.F. CHESNIMUS	2	23	8.00	0.06	0.60	6.70	2.88	1.20	1.29	2.32	0.50	37.09
S.F. CHESNIMUS	50	107	12.50	0.06	1.30	6.70	8.56	2.07	1.53	5.58	0.63	89.24
DEVIL'S	2	28	3.70	0.13	0.90	10.20	7.57	1.95	0.47	-1.22	0.46	-9.79
DEVIL'S	50	129	5.70	0.13	1.90	10.20	22.63	3.36	0.55	-1.27	0.56	-10.19
BILLY	2	45	4.50	0.08	1.90	6.30	10.00	2.24	0.53	-0.97	0.85	-12.10
BILLY	50	125	7.10	0.08	3.00	6.30	17.61	2.97	0.73	0.53	1.01	6.68
CAMP	2	153	8.40	0.06	1.60	7.50	18.21	3.02	0.85	1.73	0.53	28.82
CAMP	50	619	13.80	0.06	3.30	7.50	44.86	4.74	1.12	6.64	0.70	110.68
DOE	2	25	3.90	0.08	1.10	7.70	6.41	1.79	0.51	-0.87	0.61	-10.85
DOE	50	116	6.10	0.08	2.70	7.70	19.02	3.08	0.61	-0.55	0.88	-6.82

CULVERT OUTLET SCOUR

LOCATION	FLOOD FREQ	Q CFS	VO FPS	D50 FT	TW FT	WO FT	A SF	YE FT	FR	HS FT	TW/YE	HS/D50
GUMBOOT	2	142	5.80	0.21	1.50	15.00	24.48	3.50	0.55	-1.34	0.43	-6.37
GUMBOOT	50	444	8.20	0.21	2.40	15.00	54.15	5.20	0.63	-0.57	0.46	-2.73
ELK	2	71	3.90	0.17	1.00	13.90	18.21	3.02	0.40	-2.58	0.33	-15.15
ELK	50	333	6.00	0.17	2.20	13.90	55.50	5.27	0.46	-3.43	0.42	-20.15
CHESNIMUS	2	91	1.80	0.12	1.50	5.70	50.56	5.03	0.14	-8.29	0.30	-69.04
CHESNIMUS	50	381	7.60	0.12	2.90	5.70	50.13	5.01	0.60	-1.10	0.58	-9.16
CROW	2	135	3.90	0.04	3.00	12.80	34.62	4.16	0.34	-4.31	0.72	-107.85
CROW	50	508	10.20	0.04	5.20	12.80	49.80	4.99	0.80	2.12	1.04	52.97
MEACHAM 1	2	75	4.80	0.06	1.60	12.80	15.63	2.80	0.51	-1.42	0.57	-23.71
MEACHAM 1	50	375	7.60	0.06	4.50	12.80	49.34	4.97	0.60	-1.05	0.91	-17.55
MEACHAM 6	2	95	5.20	0.08	1.60	14.40	18.27	3.02	0.53	-1.34	0.53	-16.73
MEACHAM 6	50	500	8.00	0.08	4.10	14.40	62.50	5.59	0.60	-1.27	0.73	-15.84
MEACHAM 7	2	95	6.00	0.13	1.40	14.00	15.83	2.81	0.63	-0.34	0.50	-2.70
MEACHAM 7	50	500	9.40	0.13	3.80	14.00	53.19	5.16	0.73	0.98	0.74	7.82
MEACHAM 9	2	95	5.30	0.13	1.50	20.00	17.92	2.99	0.54	-1.21	0.50	-9.65
MEACHAM 9	50	625	9.70	0.13	4.10	20.00	64.43	5.68	0.72	0.86	0.72	6.91
SHEEP	2	20	9.00	0.25	0.70	7.00	2.22	1.05	1.54	1.38	0.66	5.51
SHEEP	50	150	16.00	0.25	2.30	7.00	9.38	2.17	1.92	8.44	1.06	33.76
CANYON 1	2	215	11.10	0.07	2.70	12.60	19.37	3.11	1.11	4.28	0.87	61.14
CANYON 1	50	675	15.60	0.07	4.80	12.60	43.27	4.65	1.27	8.81	1.03	125.81
M CANYON	2	110	6.20	0.05	1.40	13.50	17.74	2.98	0.63	-0.33	0.47	-6.65
M CANYON	50	350	8.60	0.05	2.50	13.50	40.70	4.51	0.71	0.63	0.55	12.62
CANYON 3	2	105	6.50	0.09	2.00	9.50	16.15	2.84	0.68	0.09	0.70	1.05
CANYON 3	50	345	9.00	0.09	3.60	9.50	38.33	4.38	0.76	1.22	0.82	13.56
RUBY CREEK	2	40	5.90	0.05	1.00	8.00	6.78	1.84	0.77	0.56	0.54	11.22
RUBY CREEK	50	165	8.50	0.05	2.10	8.00	19.41	3.12	0.85	1.75	0.67	35.02

CULVERT OUTLET SCOUR

LOCATION	FLOOD FREQ	Q CFS	VO FPS	D50 FT	TW FT	WO FT	A SF	YE FT	FR	HS FT	TW/YE	HS/D50
BIG CREEK	2	230	10.80	0.19	1.80	12.00	21.30	3.26	1.05	3.92	0.55	20.65
BIG CREEK	50	725	14.70	0.19	3.40	12.00	49.32	4.97	1.16	7.66	0.68	40.32
INDIAN	2	185	9.60	0.15	1.60	12.00	19.27	3.10	0.96	2.83	0.52	18.85
INDIAN	50	590	13.10	0.15	2.80	12.00	45.04	4.75	1.06	5.80	0.59	38.65
GRAN 1	2	75	4.90	0.13	1.20	12.80	15.31	2.77	0.52	-1.29	0.43	-9.95
GRAN 1	50	290	7.20	0.13	2.30	12.80	40.28	4.49	0.60	-0.98	0.51	-7.53
GRAN 2	2	75	4.70	0.25	1.20	13.10	15.96	2.82	0.49	-1.55	0.42	-6.21
GRAN 2	50	290	7.10	0.25	2.20	13.10	40.85	4.52	0.59	-1.13	0.49	-4.53
GRAN 3	2	95	6.20	0.17	2.20	13.20	15.32	2.77	0.66	-0.10	0.79	-0.61
GRAN 3	50	350	9.00	0.17	4.20	13.20	38.89	4.41	0.76	1.19	0.95	7.01
SUNFLO	2	135	7.00	0.21	1.10	17.30	19.29	3.11	0.70	0.30	0.35	1.44
SUNFLO	50	485	10.80	0.21	2.10	17.30	44.91	4.74	0.87	3.04	0.44	14.49
MARK'S	2	115	3.00	0.06	1.70	18.00	38.33	4.38	0.25	-5.69	0.39	-94.89
MARK'S	50	600	4.80	0.06	3.70	18.00	125.00	7.91	0.30	-9.09	0.47	-151.51
BROWN'S	2	100	4.20	0.04	1.80	12.60	23.81	3.45	0.40	-2.91	0.52	-69.40
BROWN'S	50	415	6.10	0.04	3.60	12.60	68.03	5.83	0.45	-4.08	0.62	-97.07
LOWE	2	440	10.50	0.13	2.60	20.50	41.90	4.58	0.86	2.80	0.57	21.57
LOWE	50	1160	14.70	0.13	3.90	20.50	78.91	6.28	1.03	7.16	0.62	55.09
POOP	2	10	8.00	0.17	0.40	4.00	1.25	0.79	1.59	1.09	0.51	6.43
POOP	50	35	11.50	0.17	1.40	4.00	3.04	1.23	1.82	4.46	1.13	26.21
PINE	2	230	13.70	0.13	1.70	7.50	16.79	2.90	1.42	6.79	0.59	54.29
PINE	50	580	17.10	0.13	2.80	7.50	33.92	4.12	1.48	10.50	0.68	84.03
HAIGHT	2	190	3.10	0.06	2.10	18.20	61.29	5.54	0.23	-7.55	0.38	-125.88
HAIGHT	50	440	3.70	0.06	3.10	18.20	118.92	7.71	0.23	-10.46	0.40	-174.30